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ABSTRACT

Technology transfer is the process of transferring knowledge and technology from one country to another. There are two basic approaches for implementing technology transfer; the *horizontal approach* and the *vertical approach*. The horizontal approach aims at transferring technology applications between developed countries where the relevant concepts already exist in the transferee country. The vertical approach aims at transferring technology accompanied by necessary knowledge from the transferor to the transferee. The vertical approach is optimal for technology transfer between developed and developing countries. Several models have been introduced to present appropriate methods for implementing vertical technology transfer between developed and developing countries. These models have given essential platforms for this purpose with rich structures and assumptions. However, these models have been criticised since they were not able to resolve significant obstacles such as the linguistic, cultural, political, and economic factors that are usually associated with technology transfer between developed and developing countries.

This research proposes a new model for implementing vertical technology transfer between developed and developing countries that takes into account several potentially influential human-centric factors. The two main characteristics of the proposed model are the inclusion of human-centric factors represented by professional immigrants in the developed countries (*diasporas*) and the benefit of dual knowledge streaming through the technology transfer process. Certain types of diasporas who possess professional skills are qualified to act as Knowledge and Technology Integrators due to their bilingual, bicultural and technology expertise (BBTs). The proposed model will be called the Dual Technology Transfer (DTT) model. The DTT model has been designed based on theoretical grounds (literature review) and empirical grounds (case studies). The literature review focuses on previously developed technology transfer models. Two different case study approaches were chosen for this research to ensure optimal results for the study by obtaining two separate streams of data. The first case study approach, which is known as a single case study (SC), is based on gathering qualitative data from one construction project and analysing its data using inductive analysis. The second case study approach, which is known as a multi-case study (MC), is based on gathering quantitative data from multiple construction projects and analysing this data using statistical analysis.

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Tampere, January 25, 2013

Neim Jabbar Karam Al-Khazarji

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LIST OF ABBREVIATIONS AND GENERAL TERMS

ASEAN	Association of Southeast Asian Nations
BBT	Bilingual, Bicultural and Technology expert
CAD	Computer Aided Design
CC's	Construction Companies
CEM	Construction Engineering and Management
CP	Cooperative Practice
DTT	Dual Technology Transfer
EIU	Economist Intelligence Unit
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
HDI	Human Development Index
ILO	International Labour Organisation
IJVs	International Joint Ventures
JV	Joint venture
KM	Knowledge Management
KTFS	Knowledge Transfer Fellowship Scheme
M&A	Transnational Merger and Acquisition
OECD	Organisation for Economic Co-operation and Development
PLC	Project Life Cycle
R&D	Research and Development
SMEs	Small and Medium-Sized Enterprises
TT	Technology Transfer
KTI	Knowledge and Technology Integrator
UI	University-Industry Collaboration
UNIDO	United Nations Industrial Development Organization
UNCTAD	United Nations Conference on Trade and Development
WWII	The Second World War

LIST OF DEFINITIONS

Construction Technology Transfer

The process of sharing the knowledge of construction industry by all means from one region/country to another, such as project management skills, building procedures, construction materials, and general construction skills for understaff.

Cooperative Practice (CP)

It refers to the possible cooperation between foreign companies and domestic companies and local professionals that maintain long-term commercial and economic relationships between developed and developing countries. CP can be implemented in different forms such as joint venture, partnership, and alliance.

Diaspora

A diaspora is an individual who is educated and qualified with latest knowledge and technology of developed country where he/she resides, and sharing a common national and/or ethnic identity. Whereas refugees may or may not ultimately settle in a new geographic location, the term diaspora refers to a permanently displaced and relocated collective.

Dual Technology Transfer (DTT):

It refers to a mechanism of two ways of knowledge and technology flow between developed and developing countries. In DTT, diasporas play a dual role in technology transfer. The first role, diasporas represent the mediators of transferring knowledge/technology from foreign professionals to local staff; whereas in the second role, diasporas represent the source of knowledge/technology flow from developed to developing countries.

Expatriate

In standard usage, the term is commonly used in the context of professionals sent abroad by their companies.

Explicit Knowledge

Knowledge that has been or can be articulated, codified, and stored in certain media. It can be readily transmitted to others.

Finn-Iraqis

Refers to Iraqis who have left Iraq and are living in Finland; they possess Finnish qualification and experience.

Horizontal Transfer

This type of transfer usually occurs among developed countries, in which only technology such as tools, instruments, methods, etc., is transferred since the knowledge already exist in the transferee country.

International Companies

International construction companies of developed countries and that have considerable international expertise, e.g. YIT Corporation, Skanska group, Rudus Ltd, Lemminkäinen Plc. SVR Plc., Mitsubishi Group, and Hyundai Group.

International TT

It refers to the technology transfer that occurs in international scale between countries. International TT is part of the general term of 'Technology Transfer (TT)' that refers to all types of transferring technology between any sort of transferor and transferee, such as between organisations, cities, regions, and countries.

Knowledge

Knowledge is understood as the qualifications and skills necessary to produce technology. It involves expertise and skills acquired by a person through experience or education (the theoretical or practical understanding of a subject). It also refers to the sum of what is currently known in a particular field (facts and information). Moreover, it also refers to the awareness or familiarity gained by experience of a fact or situation.

Knowledge Gap

This is a disparity that may occur between developed countries (transferor) and developing ones (transferee) due to the scientific, technical and managerial differences between them. For instance, a managerial, technical and scientific construction-related gap occurred between both public and private local companies in Iraq, and Finnish companies.

Knowledge and Technology Integrators (KTI)

People or professionals who have left their home country to live abroad and who are qualified to work in developed countries. They are also referred to as diasporas and their familiarity

with the languages and cultures of both transferor and transferee allow them to blend in with both foreign and local staff.

Knowledge Management

This comprises a range of strategies and practices used in an organisation to identify, create, represent, distribute, and enable the adoption of insights and experiences.

Precast Technology Transfer project cases

Precast TT projects undertaken internationally, e.g. in Iraq for the period 1978-1983 by the Finnish company Lohja Corporation (Rudus).

Research and Development

It is also known R and D or, more commonly, R&D. According to the Organization for Economic Co-operation and Development (OECD), it refers to 'creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications'.

Tacit Knowledge

As opposed to explicit knowledge which is not easily shared, and consists often of habits and culture that we do not recognize in ourselves. In the field of knowledge management, the concept of tacit knowledge refers to a knowledge which is only known by an individual and that is difficult to communicate to the rest of an organisation.

Technology

Technology is the application of knowledge embedded in a product. It can also refer to the application of scientific discoveries and inventions, which can be achieved through scientific research.

Technology Transfer

The process of sharing skills, knowledge, technologies, methods of manufacturing, samples of manufacturing and facilities among governments and other institutions (e.g. companies, research centres, universities) to ensure that scientific and technological developments are accessible to a wider range of users who can then further develop and exploit the technology into new products, processes, applications, materials or services. Knowledge and technology are seen as two mutually dependent subjects that depend upon and support each other. They cannot operate separately owing to the nature of cohesion between them that gives absolute

dependence on each other, where technology cannot be transferred without knowledge or vice versa.

Technology Transfer Projects

Projects whereby advanced technology is transferred from developed to developing countries.

Transferor

Refers to international companies having skills and the latest technologies that wish to further transfer and deliver construction projects in developing countries.

Transferee

Refers to public and private local companies in developing countries that need to improve their poor construction capabilities.

Transfer Mode

The means or vehicle, whereby knowledge or technology can be transferred, e.g. a joint venture contract.

Transferred Technology

This is target technology (in this study for example, precast technology) to be transferred within the TT process.

University-Industry Collaboration

Universities are situated at the crossroads of research, education and innovation. On the other hand, industry has a constant need for innovations to cope with the changing needs of societies. In order to bridge this needs gap, collaboration is indeed considered as a marriage between universities and the industry sector.

Vertical Transfer

This type of transfer usually occurs from developed to developing countries, in which both knowledge (explicit, tacit, and know-how skills) and technology are transferred.

CHAPTER 1

INTRODUCTION

1.1 Background and Motivation

The civilised world has experienced various economic, social and political changes and transformations throughout its history. As for the *economic aspect*, these changes are apparent in the transformations that have occurred in economic doctrine and approaches, e.g. capitalism and globalisation, and transformations from an agricultural through to an industrial and on to a knowledge-based economy. Next, *life style changes* due to the evolving needs of societies. Furthermore, the *political aspect* has had its own effect, particularly during the post World War II era. The Marshall Plan 1947-51 and the OECD; the forerunner of which was established in 1948, played an important role in the rebuilding and economic recovery of European countries. The Marshall Plan (officially known as the European Recovery Program, ERP) was the primary programme through 1947-51 run by the United States for rebuilding and creating a stronger economic foundation for the countries of Europe (Hogan M., 1987).

TT as a change maker: TT has appeared and gained gradually increasing recognition as one of the essential tools for economic development, particularly in the transition of world economies towards a knowledge-based economy dependent on new knowledge and technology. This can be seen clearly in the second half of the 20'th century when the United States, Western Europe and Japan began transferring knowledge and technology to newly industrialised countries such as Singapore, Malaysia, Indonesia and Taiwan due to their cheap labour costs (Mowery and Oxley 1995). Chinese government required to import knowledge and technology in order to improve its national economy accompanying to the global knowledge-based economy changes (Chen, 1999). Therefore, in 1978, it embraced open-door policies for industrialisation process, which promoted for Foreign Direct Investment (FDI), in order to improve its competence and know-how of industrial fields. These policies included three significant sub-policies: 'market for technology', 'export promotion', and 'upgrading industrial structure' (Zhang, 2009).

Furthermore, owing to the Industrial Revolution of the 18th and 19th centuries, and the Technological Revolution that began in the post-World War II era (Landes, 2003), technology has become an urgent prerequisite for boosting and accelerating development at all levels, particularly in the fields of construction and improving human productivity (Landes, 2003). In addition, the emerging global economy requires people at all levels who understand technology and who can use it as a tool to transform inputs into outputs or generally to achieve goals and objectives (Allam, 2009).

The TT concept combines two components, namely technology and transfer. Firstly, technology has been defined in many ways and from different angles. Simply put, it refers to a class of knowledge for making a specific product (Allam, 2009). The technical skills necessary to use a particular production technique or a product are often included within the definition of technology. Secondly, the word *transfer* means 'an act of moving something or someone to another place, organization, team, etc.' (Oxford Dictionaries). Transfer also refers to the process or the vehicle by which technology can be transferred from one place to another. In other words, it is the act by which the owner of a thing delivers it to another person, with the intent of passing to the recipient the rights s/he has to it.

The TT process aims at transferring knowledge from transferor to transferee in order to share skills and know-how. TT does not only mean the movement or delivery of technology, since for TT to be successful, knowledge also needs to be transferred, and the use of technology alone does not imply the transfer of knowledge. Therefore, transfer of technology potentially implies transferring of the correspondent knowledge (Li-Hua, 2000).

TT process and its applications: TT is a process that involves the transfer of skills and procedures from one place to another, e.g. construction skills and procedures from Finland as a developed country to Iraq as a developing one.

Modern construction projects have a requirement to improve the living standards of societies by offering safe and lasting facilities. This has led to the need for raising technological standards in TT for the construction industry in developing countries (Ofori, 1990b). Writers find it ironic that, for an activity dating back several centuries, construction in developing countries should rely on foreign techniques, materials and procedures (in Ofori, 1994; Abrams, 1964; Turin, 1973; UNCHS, 1985). Therefore, TT is attracting stakeholder interest (e.g. political decision makers, economists, investors and venture capital firms) as a tool to

improve economic development as well as public service level and human resources development.

The focus on knowledge transfer as an engine that drives TT means that researchers and scientists should make plans for TT that can be implemented smoothly. This is because human knowledge can be classified into two kinds: *explicit*, i.e. codified knowledge, e.g. text books, manuals, guides, etc.; and *tacit*, i.e. un-codified knowledge which is hard to articulate with formal language, since it is personal knowledge embedded in individual experience that can be transferred through 'intimate human interactions' (Nanoka and Takeuchi, 1995, Koskinen *et al*., 2002, Tsang, 1997; in Li-Hua, 2000), so researchers have tended to focus on tacit knowledge due to its non-codifiable nature.

Since tacit knowledge depends on intimation, such as the social dimension presented by traditions and culture, in addition to communication barriers presented by language differences. All these lead us towards the development of plans that would result in the intended purpose, namely the transfer of technology. Furthermore, TT has many crucial objectives, e.g. the transfer of some specific knowledge that is lacked by a particular country. In other words, it is to bridge any gaps in missing knowledge that may have occurred, which tends to be more the case in developing countries.

Transfer of technology covers all fields of science and engineering in various practical and theoretical areas. For example, the information technology revolution involved the transfer of technology to facilitate a positive impact on other sciences.

The human side of TT: The human side of the TT process involves linguistic, cultural and technological expertise. Researchers have developed models for the TT process discussing how knowledge can be transferred in order to fulfil TT entirely (Saad, 2000; Simkoko, 1992; Li-Hua, 2000; Waroonkun, 2007). These models are in addition to many others: project life cycle (Saad, 2000), technology acquisition (Simkoko, 1992), incorporating tacit knowledge (Li-Hua, 2000) and the value added model (Waroonkun, 2007). These models have taken knowledge to be an essential component to drive the TT process successfully. However, these models do not provide a satisfactory solution that explains how both tacit and explicit knowledge can be safely and adequately transferred. Previous research has focused on technical aspects, products and new procedures.

Consequently, most models from previous research do not consider all the possible human-related factors of technology transfer; instead, the focus is on only some of these factors. For instance, none of these models has studied the role of immigrants as a potential human factor (qualified and skilled workers in developed countries) that is capable of enhancing the TT process by offering their bilingual/bicultural skills and technological expertise. Immigration tends to take place from developing countries towards more developed ones such as Europe, the United States and Australia for political or economic reasons.

Immigrants may be either uneducated, or hold qualifications from their countries of origin, which do not in general correspond to those in developed countries. Some of these people are ambitious and keen to study at universities in their new host countries, or enter vocational schools and embark on professional training courses where they ultimately learn advanced skills and expertise. However, these people on the whole have jobs and are employed where they live. These employees, who are known as diasporas (Allam, 2009) are bilingual, bicultural and technology experts, are one of the key players in transferring knowledge to their countries of origin within the TT process.

The term *diasporas* here refers to people from a developing country (*transferee*) receiving the latest knowledge and technology while living in a developed country (*transferor*) and then transferring both this new technology and knowledge. In this study, *diasporas* refer to Iraqis who left Iraq for various reasons and headed to Europe and other countries, especially to Finland, and who, after a few decades, had lived there sufficiently long to enable them to acquire skills and qualifications in the latest construction technology in Finland. Additionally, they possess knowledge of the languages and cultures of both transferor and transferee countries. These skills (culture and language) (Carrillo, 1994) enable them to be essential players in the knowledge transfer process, in particular tacit knowledge. The use of such diasporas enhances communication that in turn facilitates the flow of knowledge within international construction operations, e.g. joint venture projects, and cements relationships and mutual trust between transferor and transferee. Moreover, it serves to eliminate time wasting and save money so that the process as a whole does not go beyond the projected budget.

In addition, diasporas create networks across the world due to their kinship and language that make business across borders easier, also help spread ideas as they educated at Western universities i.e. Foreign-educated Indians, including the prime minister Manmohan Singh

(Oxford and Cambridge) and his sidekick Montek Ahluwalia (Oxford), played a big role in bringing economic reform to India in the early 1990's (The Economist, 2011). Also, some 500,000 Chinese people have studied abroad and returned mostly in the past decade; they dominate the think-tank that advises the government. Furthermore, diasporas help companies in their host country operate in their home country. A Harvard Business School study shows that American companies that employ lots of ethnic Chinese people find it much easier to set up in China without a joint venture with a local firm (The Economist, 2011).

Owing to the huge need for construction projects in developing countries, particularly housing and infrastructure projects, construction projects have been progressing in countries such as Iraq since the late 1970s. At the same time, the internationalisation of Finnish construction companies and building product suppliers is interrelated with the overall development of the Finnish construction industry. Additionally, major changes inside Finland catalysed its internationalisation in the early 1960s and its initial growth in both the 1970s and 1980s (Palojärvi, 2009).

Diasporas and their roles: This study emphasises the human-centric factors that enhance and facilitate knowledge and technology transfer. One of these factors is to utilise the role of diasporas in integrating both knowledge and technology in a transferable pattern to their original countries. In this sense, diasporas will be referred to in this context as **Knowledge and Technology Integrators (KTIs)**. KTIs possess good communication skills due to their knowledge of languages and cultures of both transferor and transferee, which enable them to act as a genuine link between foreign staff and local staff to facilitate seamless technology transfer. In addition to the language and culture knowledge, KTIs are also distinguished by their knowledge and expertise obtained from the transferor. Therefore, KTIs are diasporas who possess the following distinctive skills:

- ***Bilingual*** is a person who commands the languages of both foreign (transferor) and local (transferee) staff.
- ***Bicultural*** is a person who is at home in the cultures of both transferor and transferee staff.
- ***Technology expert*** is a person who is skilled in the latest technology and holds relevant qualifications.

Having these skills, KTIs will be referred to in this research as **Bilingual, Bicultural and Technology experts (BBTs)**. Therefore, KTIs are diasporas who possess BBT skills. Also, in construction TT process, KTIs will play two roles. Like scissor blades, they act as mediators between transferor and transferee (foreign and local staff) from one hand, and on the other hand they act as the main source of knowledge/technology in transferring their skills to local staff directly and smoothly. Thus, KTIs have dual responsibility that enables them to be the key players in generating the so-called *Dual Technology Transfer (DTT)*, which is a unique concept to this study (see figure 6.6 chapter 6).

Finally, diasporas have three lucrative virtues (The Economist, 2011) as following:

- **First,** they speed the flow of information across borders.
- **Second,** they foster trust between transferor and transferee.
- **Third,** and most important, diasporas create connections that help people with good ideas collaborate with each other, both within and across ethnicities.

It is worth to mention that in countries where the rule of law is uncertain, which includes most emerging markets; it is hard to do business with strangers. When courts cannot be trusted to enforce contractors, people prefer to deal with those they have confidence in due to the personal ties (The Economist, 2011).

1.2 Limitations of Previous Research

The literature review of this research has investigated four existing models (the project life cycle, technology acquisition, incorporating tacit knowledge and the value-added model). The literature could easily realise that each of these models has its own focus on certain human-centric factors within the TT process that can lead the TT process towards successful transfer of knowledge and technology. Therefore, according to researches (e.g. Carrillo, Ofori), these models have given a general indication that human factors can be considered as significant contributing factors behind successful TT operations. However, the models investigated concentrated on some human factors but have not adequately dealt with the real measures behind TT success.

Nevertheless, other scholars have studied the experts and their role in facilitating the TT process. However, these results have explicitly addressed certain human factors, but have not

dealt explicitly the skills of BBTs (language, culture, and technology expertise) .This study will consider human factors from another angle that will shed light on the role of immigrants (diasporas). Diasporas are seen as Knowledge and Technology Integrators (KTIs), who can contribute significantly to making the whole TT process vital and viable.

1.3 Aims and Objectives of this Research

The ***aim*** of this research is '*to improve vertical knowledge and technology transfer process in international construction projects from developed countries to developing ones*'. This research has two main ***objectives***, namely:

- New TT Concept: To establish new understanding about the importance of involving qualified diasporas, i.e. BBTs as Knowledge & Technology Integrators (KTIs) in international construction projects to achieve efficient TT; and,
- New TT Model Development: To develop a TT model for international construction projects capable of utilising the role of human involvement in such efforts.

1.4 Research Hypotheses

Since new technology is dramatically developing in all aspects of life in an astonishing rate across the world, transferring technology between developing countries and regions is becoming a highly complex issue. Effective communication between the transferor and transferee should be considered carefully. The major concern in any international TT operation is the cross-cultural impacts. This thesis will focus on two hypotheses, which aim at providing a robust solution for TT between two countries, regions or organisations. The two hypotheses are the following:

> ***Hypothesis 1*: To overcome the impact of cross-cultural factors on the international TT operations, the involvement of intercultural professionals who possess language skills (bilingual), cultural awareness (bicultural) and technological expertise can potentially lead to successful performance of transferring knowledge and technology from the transferor to the transferee.**

***Hypothesis 2*: The involvement of intercultural professionals (or the so-called diasporas) in international TT operations leads to a novel approach of transferring technology, in which diasporas can play a dual role in the TT process; either as the mediator (integrator) between the transferor and the transferee, or as the source of the knowledge/technology to be transferred to the transferee.**

1.5 Research Strategy

The strategy for this research is divided into several parts. These parts are, respectively, theoretical (i.e. analytical) and empirical (i.e. collection of qualitative and quantitative data). The theoretical part will focus on analysing the literature review of TT in general and reviewing relevant existing TT models which in turn led to the conceptualisation model for the study at hand. Whereas the empirical part will focus on experimental data collection gathered from two main streams. These streams are Single Case Study (qualitative data collection) and Multi-Case Study (quantitative data collection). The single case study was undertaken by organising face-to-face interviews with senior participants in the Baghdad Congress Palace project from 1978-1982. The research uses case studies as its research strategy. Seppänen (2009) states, according to Yin (2003), that 'a case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between the phenomenon and context are not clearly evident'. Thus, the proposed TT model and KTI concept were tested by organising interviews and submitting a questionnaire to professionals involved in the case projects. The Multi-Case Study was undertaken by circulating an electronic questionnaire to professionals who worked in Finnish construction companies in Iraq during the 1970s and 1980s.

The following method is used to achieve the above-stated objectives of the research study:

1. Conceptual model development. This is based on investigating four existing models, namely: the project life cycle (Saad, 2000); technology acquisition (Simkoko, 1992); incorporating tacit knowledge (Li-Hua, 2000); and the value-added model (Waroonkun, 2007). These four models were discussed and analysed to determine the factors that were considered to facilitate the TT process. These factors were incorporated to identify the actual challenges that face the TT process success, thus, it

inspired the author to derive a conceptualised model that tackles these challenges by effectively utilising the human-centric factors.

2. Testing of research hypotheses and model. This is designed based on interviews for the Single Case Study and a questionnaire survey sent to professionals who were involved in construction projects in Iraq during the 1970s and 1980s. Extrapolation of data will show more general implications of identified TT factors.

3. Model refinement and validation with case studies. This is in order to show the views of professionals involved in construction projects in Iraq during the 1970s and 1980s. Interviews and questionnaires are based on the conceptualised model's drivers with a focus on human-centric factors.

1.5.1 Conceptual Model Development

The conceptual background of this research draws inspiration from two main areas: previously existing models and international construction projects where the TT process was clearly involved. Previously developed models for the TT process have addressed the rationale governing interactions between various factors of the TT process in developing countries in general, and in Arab countries in particular. Therefore, there will be a review of four models set for technology transfer, considering in the view of this study each model's strengths: (the project life cycle (Saad, 2000); technology acquisition (Simkoko, 1992); incorporating tacit knowledge (Li-Hua, 2000); and the value-added model (Waroonkun, 2007)) to be gathered together with the components of this study's model.

Several international TT projects have been reviewed and critically examined. In particular, the literature review has largely focused on experiences that are similar to Iraq's social, economic and political environment, e.g. the Algerian experience, in order to draw on the lessons learnt by its failures, obstacles and reform plans (Saad, 2000).

The literature study also focused on the involvement of BBTs, which is added as a core and essential component in the proposed TT model. Previous models have not addressed the role of BBTs as Knowledge & Technology Integrators and their involvement within the TT process. In this study, BBTs are viewed as Knowledge & Technology Integrators that form a strong link between transferor and transferee.

1.5.2 Single Case Study and Multi-Case Study

For the single case study, face-to-face interviews were conducted with six retired senior project professionals (including project leaders, a construction manager, a technical manager and a claims manager), who were involved in the Baghdad Congress Palace project (see chapter 7 for details of the project) from 1978-1982. For the multi-case study, an electronic questionnaire was emailed to professionals at Finnish companies that had been involved in construction projects in Iraq during the 1970s and 1980s. The interviews and questionnaire focused on the proposed TT model and surveyed their views on BBTs (involvement of Knowledge and Technology Integrators) and the mechanism of their integration within international TT projects. The target group was Finnish companies such as JV-IRCO-Group, JV-MALEMPO, Lohja Corporation (Rudus), YIT and others that were involved in projects during the 1970s and 1980s.

The aim of these case studies was to examine the validity of the model's factors, highlighting any potential features that may enhance the TT process and finalise the international TT model in construction projects. Case studies were used for the purpose of ensuring the accuracy of the causal paths in the international TT model.

1.6 Scope of the Study

The scope of this research is the development and implementation of an international TT model in the context of Iraq's construction environment. The developed model derived from this study aims to enhance the efficiency of BBTs as Finn-Iraqi Knowledge and Technology Integrators within the TT process on construction projects in Iraq. Such a model can help to improve the degree of understanding of the human-centric factors, i.e. bilingual, bicultural and relationship factors that impact on the international TT process, the interaction between these factors and the predominant outcomes of these TT enabling processes. Knowledge and Technology Integrators will decode so-called tacit knowledge presenting skills and know-how by socialisations (Nonoka and Tekeuchi, 1995).

1.7 Thesis Structure

This section will briefly describe how this thesis is structured. Figure 1.1 illustrates the order of the chapters.

Chapter 1: includes the introduction to the research topic.

Chapter 2: details the research method and the envisaged outcomes for each stage of the research. The research method consists of three main research stages: (1) conceptual model development; (2) testing of the research hypotheses, and; (3) case studies of past Finnish experience in Iraq to refine and validate the model. Specifically, this chapter describes the research tools used, data collection methods, data analysis techniques and the desired research outcomes.

Part I – Literature Review

Chapter 3: contains a description of TT as phenomena, a definition of TT, TT anatomy, and a definition of the main relevant enablers involved within the TT process.

Chapter 4: focuses on certain human-centric factors as the core of this study. These factors are, namely bilingual, bicultural and technology expertise.

Chapter 5: provides a review of the TT literature, with an emphasis on studies conducted in the construction sector. In particular, existing models of international TT are examined and relevant factors extracted for the purpose of developing a conceptual model for international TT in construction projects. Additionally, experiences from precast TT in Iraq are covered.

Part II Conceptual model development

Chapter 6: developing a conceptual model for the international construction TT process. This conceptual model accommodates the numerous factors believed to impact on the effectiveness of the TT process and its derived outcomes.

Part III Empirical Part

Chapter 7: this gives the reasoning behind adopting multiple case studies (single case study and multi-case study) that use both qualitative and quantitative data collection.

Chapter 8: Analysing data collected by the single case study interviews and the multi-case study questionnaire and discussion to refine the proposed TT model that highlights the validation of the new causal path for the international TT process.

Chapter 9: Conclusion including the major outcomes, contribution, limitation and future study of this research.

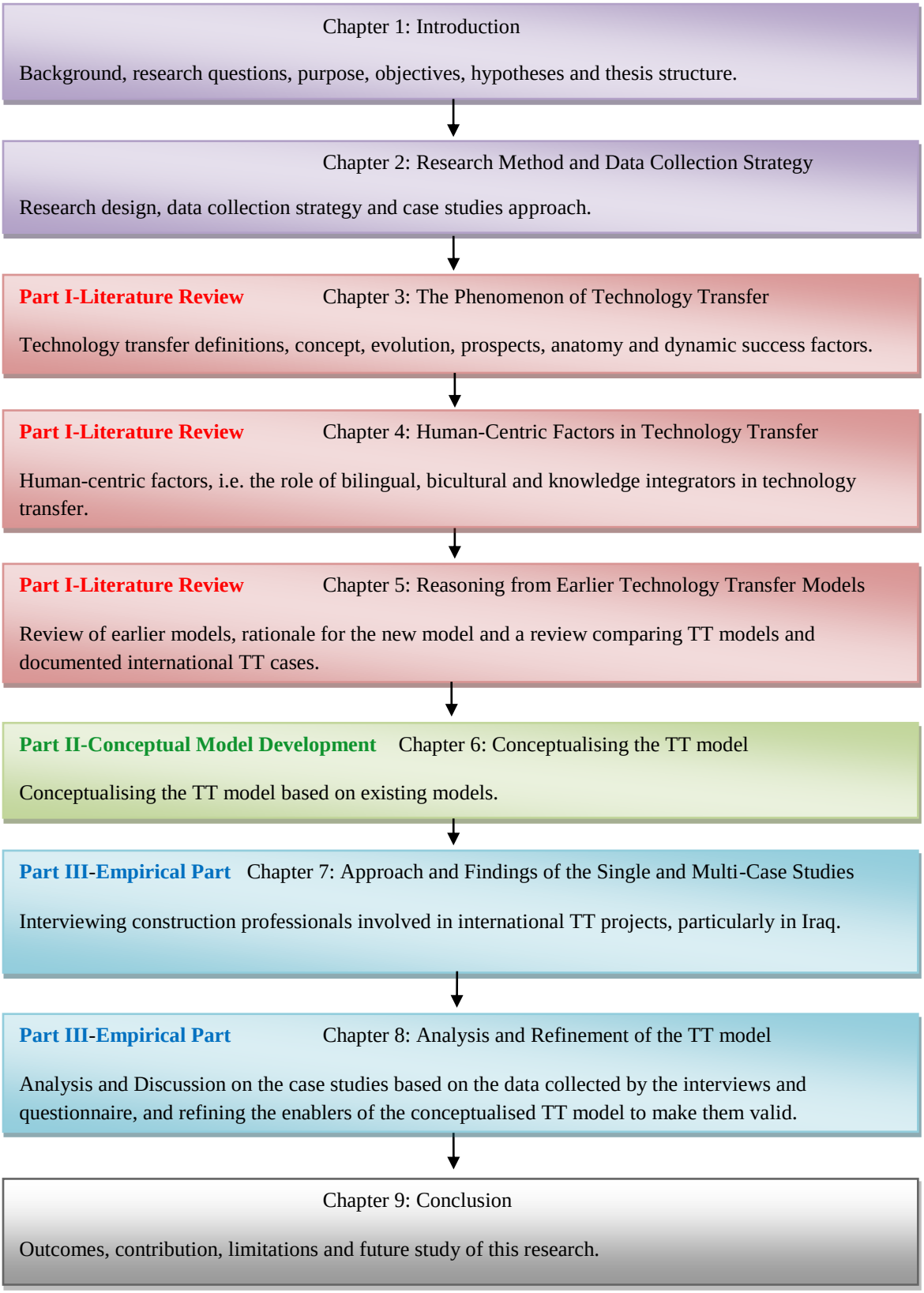


Figure 1.1: Research phases and corresponding structure of the thesis

CHAPTER 2

RESEARCH METHODOLOGY

2.1 Introduction

This chapter describes the background and reasoning behind the chosen research methodology. The methodological debate on research is commonly held at several differing rhetorical levels, often in the form of an elaboration of preference between perceived opposites on a continuum, e.g. natural science-social science, rationalism-empiricism, induction-deduction and qualitative-quantitative (Leiringer, 2003). These continuums do not necessarily occur, so the interrelationships between them are not always clear. On the other hand, both science and philosophy try to consider human experience to be involved as an essential component for research approaches (Yildirim, 1971). According to Schell (1992) 'a case study is the most flexible of all research designs, allowing the researcher to retain the holistic characteristics of real-life events while investigating empirical events.'

However, scientists have to find out what is the most suitable procedure that should be followed regarding the nature of research objects and field of study. The method used should be appropriate for the specific research questions, aims and objectives, i.e. the type of knowledge to be discovered-descriptive, explanatory or exploratory (Yin, 2008; Wing et al. 1998). Furthermore, to be appropriate it is meant not only how well the chosen method is suited to the research problem at hand but also how well it fulfils the practical limitations that are undoubtedly set on the study.

Therefore, for obtaining valid and well-grounded results, this study applies certain research approaches that cover the planned research process as a whole. The methodology of this research is based on a three-pillared approach (see figure 2.1) that consists of (i) a literature review where existing TT models are reviewed, (ii) a single case study (Baghdad Congress Palace) where in-depth data is collected, and (iii) a multi-case (questionnaire survey).

2.2 Research Approach

The choice of research approach is basically affected by considering the required scope and depth of the research domain. According to Fellows and Liu (1997), the choice is between a broad, but shallow, study at one extreme, and a narrow, but in-depth study at the other, and a study in between these two extremes. Data collection tools were used in this research, including face-to-face interviews and questionnaire surveys.

The research approach for this study is based on three main pillars (figure 2.1) according to the triangulation principle in order to enhance confidence in the ensuing findings (Bryman, 1992). The **first pillar** comprises two phases. The first phase is based on a literature review of international TT models between developed and developing countries. The outcome of the first phase will be a proposed TT model. The second phase will be used together with the second and third pillars to validate the proposed TT model. The **second pillar** adopts the Baghdad Congress Palace in Iraq as a single case study, which is based on in-depth interview data collections. The **third pillar** is represented by a multi-case study questionnaire survey that collects data from professionals involved in various projects implemented in Iraq during the 1970s and 1980s.

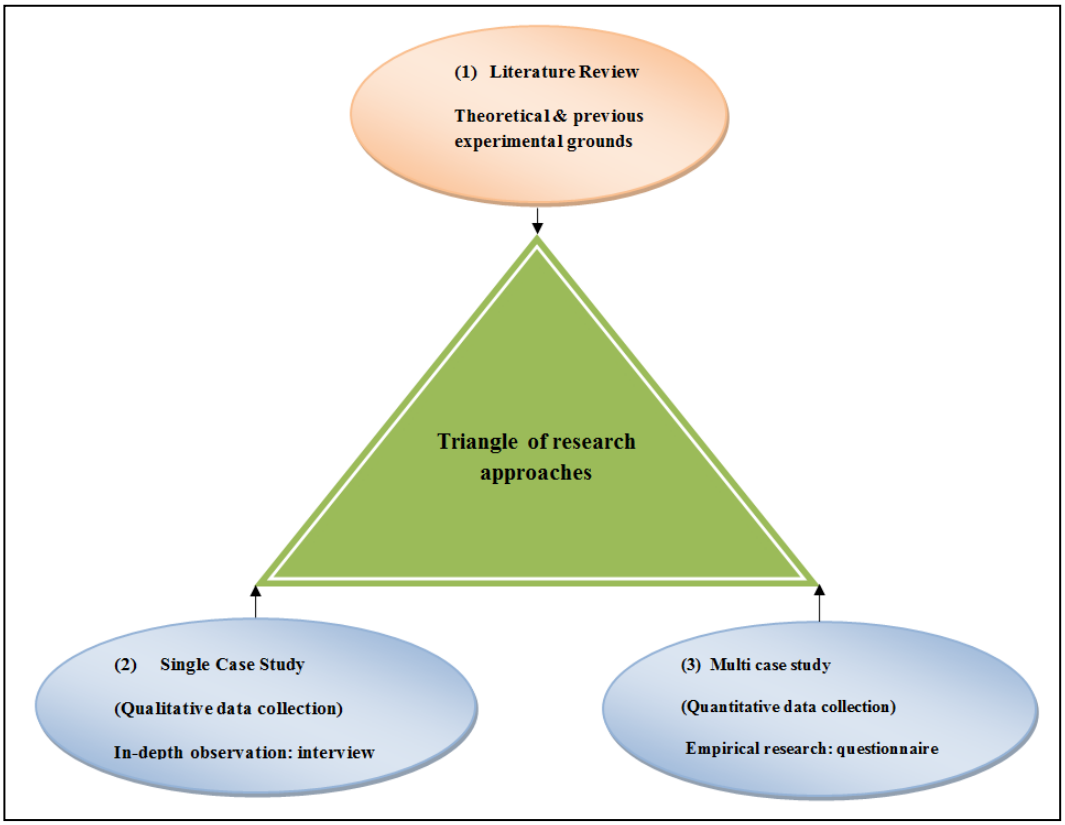


Figure 2.1: Tri-pillar approaches for research methodology

Finally, in addition to the second and third pillars to test the resulted model, more recent supporting evidence from international TT operations and the author's own experience will be utilised.

2.3 Modelling

In a general sense, a *model* is anything used in any way to represent anything else. Models are used to facilitate knowledge and understanding of the subject matter they represent. A more specific term associated with models is the conceptualised model that refers to the elements of models represented by certain concepts that originate from a conceptualisation process.

The needs and ideas for modelling are grounded on the necessity of designing a TT model that utilises and focuses on the human aspects in facilitating the TT process. The previous TT models that have been conceptualised for TT process between developed and developing countries were reviewed as a part of literature review. Reviewing exiting conceptualised models covered the period of 1970's, 1980's and 1990's for developing countries including Algeria, Tanzania, Thailand and China. These models show that human aspects have an essential impact on the progress of the TT process. Nevertheless, these existing models identify the gaps and weaknesses occurred in TT process, but have not explained yet how TT process can be improved effectively by avoiding such gaps and weaknesses. In this research, four models conceptualised for the vertical TT process from developed to developing countries are reviewed in-depth and clear for the purpose to understand the most effective human factors on the TT process. The modelling considers the transfer environment in terms of human factors, i.e. linguistic, cultural, political and regional aspects. The literature review covered previous models, highlighting the strengths of these models, and incorporated these strengths into the structure of the proposed model of this study.

2.4 Case Studies

The case study research method is highly suited to bringing us to an understanding of a complex issue or object and can extend experience or add strength to what is already known through previous research (Soy, Susan K. (1997). Case studies emphasise detailed contextual analysis of a limited number of events or conditions and their relationships. Researchers have

used the case study research method for many years across a variety of disciplines. Social scientists, in particular, have made wide use of these qualitative and quantitative research methods to examine contemporary real-life situations and provide the basis for the application of ideas and extension of methods.

The case study research method has been found to be an ideal methodology when a holistic, in-depth investigation is needed. There have been various investigations about the concept of case studies, particularly in sociological studies. It has also been noticeable increase in the construction field. Researchers such as Yin, Gerring, and others who have investigated the concept of *methodology* have also proposed procedures that can be followed by researchers as well-developed and tested as any in the scientific field. Whether the study is experimental or semi-experimental, methods of data gathering and analysis tend to ignore some details. *Case studies*, on the other hand, are designed to reveal the details of the experience and opinions of the participants by using multiple sources of data (Seidman, 2005, Hancock, 2006, Gerring, 2006, George, 2005).

Two case studies were used in this research, represented by the single case study and the multi-case study, which will be introduced in the next subsections.

2.4.1 Single Case Study (SC)

A single case study is a special type of case studies where an in-depth investigation of a single individual, group, or event is carried out. It refers to the collection and presentation of detailed information about a particular participant or small group, frequently including the accounts of the subjects themselves. A form of qualitative descriptive research, the single case study looks intensely at an individual or small participant pool, drawing conclusions only about that participant or group and only in that specific context (Yin, 2008).

Many well-known case study researchers such as, Helen Simons (2009), and Robert K. Yin (2008) have written about case study research and suggested techniques for successfully organising and conducting research. However, for this research the most prominent project within the construction industry built abroad by Finnish companies for the period 1970's 1980's is Baghdad Congress Palace (built 1978-1982), which was chosen as a single case study due to the nature of circumstances that surrounded the project at the time.

In order to ensuing findings, face-to-face interviews with six retired senior Finnish professionals involved in the project in question were undertaken as part of this study. These interviews took place in December 2010 at VTT premises (Technical Research Centre of Finland) in Espoo, Finland (see Appendix I for the pre-prepared list of main questions). All interviews were recorded with devices provided by VTT. The scheduled time was two hours per interview. Furthermore, interviewees were very interested to discuss much more than set questions and brought all documents related to the project including diaries, log books, memoirs and specific details of the project.

2.4.2 Multi-Case Study (MC)

A multi-case study is a basic type of case research where more than one research objects (e.g. project, company or business-case) is explored. This approach is based on conducting questionnaire which can be sent either by mail or electronically to the professionals involved in projects that will be covered by the questionnaire.

The purpose of this questionnaire is to explain the relationships between selected variables. The underlying intention when conducting questionnaire surveys is to draw inferences from populations (Moser and Kalton 1985), though there are times when representativeness is of minor importance. The term *population* is used in a statistical manner to imply the aggregate of persons or objects under investigation. Thus, the questionnaire survey research method, in contrast to, for example, ethnography, focuses on the population in which the phenomenon under investigation occurs rather than on the social setting in which it is embedded.

Moser and Kalton (1985), claim that there are some aspects of human behaviour that cannot be investigated through the means of surveys. The method has the advantage of allowing a greater sample of projects to be included in the research whilst limiting the human resources committed by the research team. The means of acquiring the required data can vary from highly structured questionnaires to unstructured interviews depending on circumstances and the topic of interest. If undertaken properly the degree of generalisation from survey research promises to be high. This is a direct result of the strategy for statistical populations, which permits survey researchers to say with a known degree of confidence how well a particular sample of subjects represents the population from which it was drawn. Surveys have been

demonstrated to be effective in answering research questions such as ‘who’, ‘what’, ‘where’ and ‘when’ (Yin 1994).

A data gathering is a means of ‘gathering information about the characteristic, actions, or opinions of a large group of people referred to as a population’ (Mcadams, 1982). This study focuses on a questionnaire survey that is conducted to advance scientific knowledge. The broad area of the survey encompasses any measurement procedures that involve asking carefully chosen questions to the participants.

This study adopted the data gathering principle to better understand the TT phenomenon since the statistical population principle cannot be fully employed. Therefore, an electronic questionnaire survey (see Appendix II) is utilised in this research. The questionnaire was sent to Finnish participates who were involved in construction projects in Iraq between the 1970s and 1980s. As the majority of the respondents are currently retired, the electronic version of the survey was sent via electronic mail, in order to reach them more easily and to speed up the data gathering task.

Unlike the regular social science research, the quantitative research in Construction Engineering and Management (CEM) often rely on alternative research techniques when traditional methods are difficult to be utilised due to different reasons, such as the limited size of the representative sample or population. Alternative research methods in CEM, such as the Delphi method, can allow researchers to obtain highly reliable data from certified professionals through the use of strategically designed surveys (Hallowell, 2010).

In this thesis, since the total population of the targeted Finnish professionals in the questionnaire is unknown, thus the representative sample of participants is also unknown. Consequently, the thesis does not claim to present a representative sample, but instead, it relies on the concept of ‘data saturation’ in social science research, which is proposing that the amount of research data gathering is closing the satisfying level that when the answers start to repeat what was learnt and the findings are comprehensive (Francis, 2010).

2.5 Research Design

One of the main drivers that inspired the author of this research to conduct this study is to utilise the previous experiences in the construction TT process to propose a new model that avoid repeating the mistakes of the past over and over again. In 1973, Iraq nationalised foreign oil companies which were working in Iraq's oil production (Metz, 1988). Iraq as a developing country has undertaken TT programmes in various fields. For instance, the construction industry has played a significant role due to its contribution to military projects and the oil and metal industries.

A number of construction TT endeavours took place during the 1970s and 1980s from developed countries with good political ties with Iraq at that time. Finland was a major player in construction projects in Iraq, because it was one of the non-allied countries, and due to the efforts of Iraqi ambassador Ammash in Helsinki (Palojärvi, interview 2011). Unfortunately, the TT process was not successful due to various reasons and factors, including political interference by the Iraqi government excluding local expertise from projects, for national security reasons from the point of view of the Iraqi government. These factors will be discussed in details in chapter 7 and will be taken into account and incorporated in the conceptual model developed in this study. Furthermore, this study can be taken into account as part of a proposed solution for construction TT from developed countries into Iraq.

This study considers these case studies to facilitate developing a new model based on examining a number of different industry sectors. Accordingly, the aim of this section is to examine existing models developed across various industry sectors with an emphasis on construction TT projects.

The first model (Saad, 2002), which discussed the project life cycle, emphasised the importance of the ability of the local staff to work independently after the project completion (post-project performance). The second model (Simkoko, 1992) considered the technology acquisition by the local staff as the core of the TT process. The third model (Li-Hua, 2000) incorporated the tacit knowledge and discussed how to facilitate the process of decoding the tacit knowledge. In terms of the value-added model (Waroonkun, 2007); the focus is on how successful the local staff can be in managing similar projects in the same level of performance done by the foreign staff (transferor).

The conceptual model (finally known as the DTT model) will be developed through a process of justifying, grouping, comparing and refining factors established across the researchers' models mentioned above.

The research designed consists of four fundamental stages (see table 2.1): (1) literature review; (2) modelling (conceptual model development); (3) single case study (interview: qualitative data) and multi-case study (questionnaire survey: qualitative data); and (4) refining and validation of the model.

Stage I: The literature review has been conducted on the basis of available literature, including printed and online sources. This analysis of literature has three parts: firstly, the issues of TT are explored; secondly, the construction TT process in developing countries, particularly in Arab countries; thirdly, conducting reviews and conceptualising models for TT. This literature review is based predominantly on secondary data that has been evaluated and analysed for crafting policy development for construction TT from Finland to Iraq.

Stage II: Modelling (Conceptual Model Development) – The aim of this stage is to develop a conceptual model for vertical TT in construction projects and determine the main factors and sub-factors of this model based on the literature review undertaken in chapter 5.

Stage III: (Case studies: interview & questionnaire survey) – The aim of this stage is data collection including single case and multi-case studies followed by an analysis of the empirical data. Case studies were conducted for international companies that were carrying out construction projects in Iraq during the 1970s and 1980s, e.g. IRCO-Group built the Baghdad Congress Palace from 1978-1982, and Rudus Corporation (formerly called Lohja) built four precast factories for seven housing projects in Iraq from 1978-1983.

Stage IV: (Model Refinement and Validation) – This stage aims to refine and validate the conceptual model for vertical TT in construction projects through a series of project-based case studies where vertical TT was implemented.

Table 2.1: Main research design focusing on the following research tasks and outcomes

Stage	Description	Outcomes
1. Literature Review	• Review of TT research in the construction field and other related research areas • Review of existing TT models to create a new model which is relevant to construction projects	• Understanding of human effective factors that impact on the TT process and its outcomes
2. Conceptual Model	• Extracting effective human-centric impact	• Conceptualising model of TT in international construction

	• Taking into account the political impact	projects
3. Data collection 3.1 Single Case Study (projects) 3.2Multi-Case Study questionnaire survey 3.3 Analysis	• Conducting an in–depth (face-to-face) interview • Conducting questionnaire survey throughout Finnish construction companies, particularly those which were involved in construction projects in Iraq • Collecting empirical data • Statistical analysis was used	• Justification of the conceptual model • Improved understanding of TT enablers, human factors and their impact on the outcome
4. Model Refinement & Validation	• Refining and finalising the model for international TT in construction projects	• Validation of the model for international TT in construction projects

The target respondents in this research include the Finnish construction professionals and their associates, who participated in Finland-Iraq TT programmes, since this research is based upon an in-depth qualitative study of Finnish construction companies working in Iraq during the 1970s and 1980s. Hence, the research method must be designed in a robust manner to obtain data to test hypotheses and the proposed model.

Due to the specific nature of the research subject which concentrates on modelling the construction TT model between Finland and Iraq, it is crucial to adopt single and multi-case studies to validate the suggested model of the construction TT process. The questionnaire survey was conducted for companies involved in previous construction projects and the TT process implemented in Iraq, and for those companies in general that were involved in TT projects in developing countries. The questionnaire survey will collect very essential and accurate data as it may ask the same people of Finland involved in construction projects and the TT process in question. Questioning people and staff of companies involved in construction projects in Iraq yields essential and sufficient data that can be trusted. Utilising this approach should ensure that the model developed for international TT in construction projects is reliable and valid.

Data collection and analysis revolves around stage III, including: single case study interview qualitative data collection and multi-case study questionnaire survey quantitative data

collection followed by stage IIII, including: model refinement and validation. Figures 2.1and 2.2 illustrates the steps undertaken to achieve the research objectives. Table 1 also details each stage of the research process and describes tasks and associated outcomes.

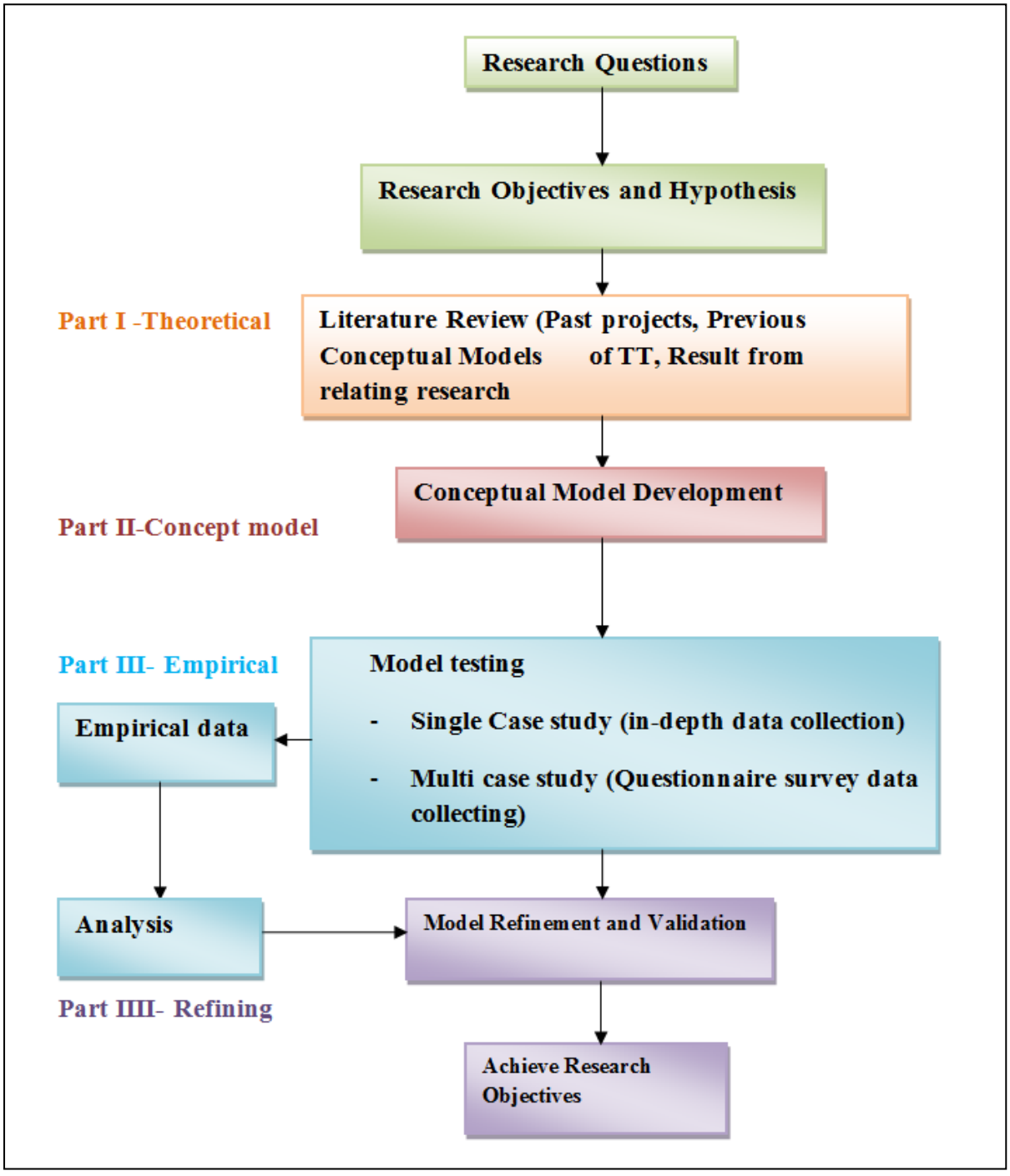


Figure 2.2: Road map of research phases

2.6 Conceptual Model Development

The modelling approach of this study is based on the literature review of relevant developed models and on international construction TT operations. Therefore, the conceptual background of this research draws inspiration from earlier developed models for the TT process including the project life cycle (Saad, 2000), technology acquisition (Simkoko, 1992), incorporating tacit knowledge (Li-Hua, 2000) and the value-added model (Waroonkun, 2007). Taking every single model's strength enabler to be incorporated in the developed model alongside this study's focus on the human factors (BBTs) possessed by diasporas (qualified Iraqis living abroad, particularly in Finland) and their involvement as KTIs (Knowledge and Technology Integrators) within the whole TT process can be considered a solid foundation for testing the overall model. The human factors are clearly focused on in previous models. This is presented in every single model as follows:

(i) The project life cycle model (Saad, 2000) concentrates on one of the fundamental elements, namely training of local workers and enhancing their performance through monitoring and emphasising the acquisition and assimilation of imported technology in order to achieve international standards, reflected in future project performance independently.

(ii) The technology acquisition model (Simkoko, 1992) focuses on two out of seven key factors. On one hand, the project management team is concerned with the degree of integration of local and foreign project managers. On the other hand, the project performance is concerned with the competence development of local firms measured by the degree of involvement and the impact on local employment.

(iii) Incorporating the tacit knowledge model (LI-Hua, 2000) focusses on tacit knowledge transfer which is measured by how human beings can facilitate its codification.

(iv) The value-added model (Waroonkun, 2007) concentrates on the relationship and communication between transferor and transferee that build up a culture of mutual trust, along with the transferor being willing to transfer appropriate technology and the transferee being willing to learn.

In keeping with the discussion mentioned above, the human-centric factors are present and vital within the TT process. Therefore, this taught model will focus on the human-centric factors that integrate the TT process to be succeeded as a whole.

2.7 Empirical Testing of the Model

The next step is the model testing by the help of professionals involved in international construction TT operations, particularly in Iraq and developing countries.

The majority of research in the social science and management fields involves asking and obtaining answers to questions through conducting surveys of people and by using questionnaires, interviews (face-to-face or telephone interviews) and case studies (Fellows and Liu, 1997). In general, researchers encounter a so-called limited availability of resources for carrying out the required fieldwork and those resources are sometimes very restricted. The testing questionnaire includes problem-solving questions that allow the applicant to think creatively, as well as questions that elicit more than a 'yes' or 'no' response.

This study will test all aspects that directly or indirectly affect the conceptualised TT model for construction technology into Iraq. Testing will cover all gathered data of both single case study and multi-case study alike. The testing for the single case study is achieved by conducting face-to-face interviews for senior professionals involved in Baghdad congress Palace (1978-1982) (see page 118). Whereas, the testing for the multi-case study is achieved by sending questionnaire asking Finnish senior professionals involved in construction projects implemented in Iraq during the 1970's and 1980's.

The interviews and questionnaire surveys for validation of the conceptualised model issued to the respondents are shown in Appendices (I) and (II). Additional information also solicited from respondents, such as years of experience, position, education, etc., are also shown in Appendices (I) and (II).

This study has adopted both the interview and questionnaire to increase the reliability of the resulted outcomes.

- **Single-Case Study**

  The single case study interviews were conducted with a group of six senior executive Finnish professionals, involved within the Baghdad Congress Palace project (1978-1982). The interviews took place in December 2010 at the VTT premises in Espoo city in Finland. The scheduled time was two hours per interview, and topics of test (see page 118).

- **Multi-Case Study**

The multi-case study was performed by conducting a questionnaire survey. The survey was developed based on the developed DTT model. Also, the author has made individual contacts with experts from Finnish construction industry. They provided general relevant facts regarding the importance of the local staff involvement in construction projects, which was beneficial for the survey questions. The questionnaire survey was conducted for a Finnish target group involved within TT programmes. The questionnaire starts with Finnish companies. Collection of quantitative data from Finnish construction companies involved in construction projects aids the research process to refine and validate the proposed TT model.

- **Analysis Methods**

Interview data analysing took place by extrapolating patterns from the answers of executive professionals involved in the Baghdad Congress Palace project (1978-1982). As for the main questionnaire survey, statistical techniques were used to analyse the quantitative data in order to answer the research questions posed. The statistical Package for Social Sciences (SPSS) is employed for this purpose.

2.8 Model Refinement

The case studies are utilised to refine and apply the developed model in the international TT process for the construction industry. This phase shows the statistical analysis giving the means of each individual factor of the conceptualised model developed in this study and their validation of the casual paths in the international TT model, together with its application.

2.9 Summary

This chapter describes the method chosen to study the vertical TT in the international construction projects in Iraq. The focus was on (i) the development, (ii) refinement and (iii) validation of the model. Finnish professionals, who were involved in international construction projects in Iraq during the 1970s and 1980s, will be interviewed and questioned to examine the TT enablers and their sub-factors (this will be covered in the next chapters) such as the transfer environment and learning environment (will be covered in chapter five and six). Moreover, it focused on measuring the outcomes of the TT strategy in the following categories: project performance; knowledge resettlement and integration; return migration by involving diasporas (qualified Iraqis living abroad) within the TT process; and economic advancement.

CHAPTER 3

THE PHENOMENON OF TECHNOLOGY TRANSFER

3.1 Introduction

This chapter aims to introduce the concept and theory of the TT process and identify its elements, fundamental characteristics and anatomy. It will discuss the world of TT in terms of the origin of TT as a paradigm.

This chapter starts by describing the industry and gives a business-oriented presentation of TT. It will then move on to the theory of TT. This includes three aspects: (i) elements forming TT; (ii) the anatomy of TT; and (iii) fundamental characteristics of TT operations. In addition, research and development is discussed as enablers for TT. Next, four key factors behind TT will be discussed, including the technology to be transferred, knowledge acquisition, transfer modes (vertical and horizontal), and local staff training. Finally, the chapter ends with a review of future prospects for TT.

3.2 Industry and Business-Oriented Presentation of TT

Knowledge and technology are seen as two mutually dependent subjects that depend upon and support each other. They cannot operate separately owing to the nature of cohesion between them that gives absolute dependence on each other, where technology cannot be transferred without knowledge or vice versa. However, scholars have looked at various views based on the required needs and location (in a geographic sense) (Li-Hua, 2000).

Technology transfer is not a new phenomenon. It can be understood as an important foundation of human civilisation. Technology has been transferred from parents to children and between neighbours and community members since the very beginning of human evolution when people started to use hand tools to kill or catch animals or to pick up fruits (Amin, 2005). Technology transfer (TT) is essentially a process by which instruments and procedures are conveyed physically, in addition to the movement of know-how that is usually embedded in human skills from place to another.

The concept of TT was first born in the industrial developed countries. After World War II, many war-ravaged countries boosted their economic development through TT and monetary assistance from the United States.

The operation of TT is one that can be traced back to the post-World War II era when reconstruction of Europe and Japan took place**.** This period of TT occurred in an environment where the key challenge was to rebuild an industrial and physical infrastructure that had been extensively damaged due to the war. Technology transfer began in the late 1950s and early 1960s (Rudi, 2000 and Saad, 2000) as former colonies in Africa and elsewhere became nation states, resulting in a growing interest in transferring technology between ‘developed’ and ‘developing’ countries. This shift involved a set of historical, political, economic, and socio-cultural considerations that are very different from the post-Second World War reconstruction context, which inevitably impacted on the success of TT to developing countries.

As money or financial resources were the main problem for most developed countries, the World Bank and International Monetary Fund provided them with loans to purchase technology. However, the funding bodies also imposed conditions for economic development through their prescriptions, with only a few exceptions, that the technology sold by Europe

and North America to the developing nations of Africa and Asia to be obsolete and often outrageously over-priced (Amin, 2005).

TT is often understood as shared responsibility between the source and the destination for ensuring that technology is accepted and at least understood by someone with the knowledge and resources to apply and/or use the technology (Waroonkun *et al.,* 2005b). Also, it is also understood as a process of translating new information into a form that can be comprehended and evaluated, and which will finally result in an informed decision to reject or adopt the innovation (Tony *et al.,* 1995 http//orgonstate.edu). However, scholars have understood the term TT in many different ways, including: the transfer of technology from one place to another; from one group to another; from one organisation to another; from a university to an organisation; and from one country to another (Solo and Rogers, 1972). Sorensen and Chambers (2008) have defined success in TT in academia as a function of defining what outcomes are desired, then tracking and measuring performance in light of those desired outcomes.

International TT is considered to be a vehicle for transferring knowledge from developed or industrialised countries to less developed (LDCs) or developing countries, and to develop their national economies by increasing Gross Domestic Production (GDP) (Yamashita, 1991).

UNCTAD (1979) defined TT as 'the transfer of systematic knowledge for the manufacture of a product, for the application of a process, or for the rendering of a service.' Simkoko (1992) attempted to build on this definition by identifying individual construction resources, as either materials or permanent equipment (e.g. steel beam, elevators, material) or construction-applied resources (e.g. information, skills). Williams and Gibson (1990) defined TT as the shared responsibility between the source and the destination by ensuring that technology is accepted (or at least understood) by someone with the knowledge and resources to apply and/or use the technology. Besides, Stewart and Nihei (1987) explain that technology refers to new and better ways of achieving economic ends that contribute to economic development. Hussain (1988), meanwhile, classifies the term technology as the knowledge or skills required for doing something that satisfies human wants or which is useful; in other words, the term refers to information and know-how.

3.3 Theory of Technology Transfer

The philosophy and theories that can be identified behind TT are the process of transferring explicit or tacit knowledge (Nonaka and Takeuchi, 1995; Li-Hua, 2000), as well as technologies transferred from one place to another by various means, e.g. imitation, socialisation or taught courses (Nonaka and Takeuchi, 1995). The TT process often occurs either to improve the capabilities and qualifications of local staff in order to ultimately increase workers' productivity, or in the process of looking for inexpensive labour in a way that may reduce the cost of production. Therefore, the real motives for TT operations are economic, social or political.

The concept of TT has been gaining attention by both developed and developing countries over the last three decades, with a great deal of interest in the concept being recorded in the literature and the media. Technology transfer, however, has different meanings to different people. It may indeed have a variety of definitions to an individual.

Organisational units dedicated to TT have mushroomed in each sector of the industrialised and newly industrialising countries' economies. Technology transfer evolved as a practice before it became recognised as a profession. Therefore, there is as yet no agreement regarding an overarching definition that includes all of the elements and processes involved between technological innovation and product production (Lane J., 2003).

To clarify the TT theory in more detail, the next three subsections will demonstrate the main elements that form TT, the anatomy of TT, and the fundamental characteristics of TT operations.

3.3.1 Elements Constituting Technology Transfer

Scientists and researchers have written on the subject of TT but because of the ambiguity in defining the concept it has proved difficult to determine the exact meaning of the term. Simply focusing on the product is not sufficient for the study of transfer and diffusion of technology; it is not merely the product that is transferred but also knowledge of its use and application. As an approach, it resolves a major analytical problem: the difference between knowledge and TT. According to literature (McInerney, 2010; Leydesdorff, 2006; Laudan, 2010), concept the two are inseparable; when a technological product is transferred or

diffused, the knowledge upon which its composition is based is also diffused. Without the knowledge base the physical entity cannot be put to use. Thus, the knowledge base is inherent, not ancillary. However, this study considers TT as a concept resting on three fundamental elements:

- **Knowledge:** is understood as qualifications and skills to produce the technology. It involves expertise and skills acquired by a person through experience or education (the theoretical or practical understanding of a subject). It also refers to what is known in a particular field or in total (facts and information). Moreover, it also refers to the awareness or familiarity gained by experience of a fact or situation.
- **Technology:** is understood as the application of knowledge embedded in a product. It can also refer to the application of scientific discoveries and inventions, which can be achieved through scientific research.
- **Transfer mechanism:** this is the mechanism by which knowledge and technology can be transferred to be diffused from place to another.

Therefore, the proposed model aims to transfer technology by first transferring the relevant knowledge through an efficient transfer mechanism. This research focuses on transferring construction knowledge and technologies vertically to developing countries.

3.3.2 Anatomy of TT

The term *anatomy* is used here to refer to a detailed analysis and examination. In terms of TT anatomy, we can look at the TT process as a whole, from both external and internal aspects. The TT concept can be viewed using an analysis method for reviewing macro-environments in light of all possible external forces, called PESTLE analysis. PESTLE stands for Political, Economic, Sociological, Technological, Legal, and Environmental. These factors may have an impact on the success of the TT process (Strategy Survival Guide, 2011). The PESTLE model provides users with a series of headings under which users can brainstorm or research key factors:

- **Political:** that which is happening politically in the environment in which an individual or organisation operates, including areas such as: tax policy; employment

laws; environmental regulations; trade restrictions and reform; tariffs; and political stability.

- **Economic:** that which is happening within the economy, for example: economic growth/decline; interest rates; exchange rates; inflation rates; wage rates, the minimum wage; working hours; unemployment (local and national); credit availability; cost of living, etc.
- **Sociological:** that which is occurring socially in the markets in which an individual or organisation operates or expects to operate, such as: cultural norms and expectations; health consciousness; population growth rate; age distribution; career attitudes; emphasis on safety; and global warming.
- **Technological:** that which is happening technology-wise which can impact on what can be achieved. Technology is racing forward every two years, which will impact on products and services. Things that were not possible five years ago are now considered mainstream, for example mobile phone technology, Web 2.0, blogs, and social networking websites. New technologies are continually being developed and the rate of change itself is accelerating. There are also changes in barriers to entry in given markets, and changes to financial decisions such as outsourcing and in-sourcing.
- **Legal:** that which is happening regarding changes to legislation that may impact on employment, access to materials, quotas, resources, imports/exports, taxation, etc.
- **Environmental:** that which is happening with respect to ecological and environmental aspects. Many of these factors will be economic or social in nature.

According to the PESTLE model, the situation in most countries is moving towards a favourable global change such as a market economy and globalisation. This has happened particularly in developing countries due to the reform measures adopted by new governments that have made political, social and economic changes and put into place reform measures. From the political perspective, the government seeks to attract as large a number of investors as possible through enacting measures that facilitate and encourage them in order to improve the country's economy and create jobs for the unemployed through housing and infrastructure projects. This is clearly reflected in the Iraqi investment law issued in 2006, which permits the right to own land by the investor. Noting that, International construction companies, e.g. Lohja Corporation (Rudus) have previously implemented various projects in Iraq, especially construction, and in particular precast housing projects, which have been well-received there.

3.3.3 Fundamental Characteristics of TT Operations

Knowledge within TT can be divided into two categories: (1) internal knowledge and (2) external knowledge. Internal knowledge is more readily available in an environment, while external knowledge is more scarce, which makes it more special and unique (Menon, 2003). These categories of TT are to be considered when looking at knowledge and technology transfer to and within a country or company. According to Andrezej (2005), TT can be classified into two paths: *vertical* technology transfer – the flow of knowledge from research institution to companies; and *horizontal* TT – the flow of knowledge among companies. Whereas, according to Li-Hua R. (2005), knowledge transfers are divided into two components – *explicit* knowledge and *tacit* knowledge transfer (discussed further later in this chapter).

However, according to Saggi (2002), TT usually happens in two essential paths: vertical transfer and horizontal transfer (figure 3.1).

- **Vertical transfer:** This type of transfer usually occurs from developed to developing countries, in which both knowledge (explicit and tacit skills) and technology are transferred. Knowledge and technology transfer can occur from one organisation to another, from one university to another or from a developed country to a developing country. This kind of transfer is essential between developed and developing countries owing to the fact that technology cannot be transferred unless relevant knowledge is also transferred (Li-Hua, 2000). Vertical TT usually occurs between multinational corporations (MNCs) or firms in developed countries (DC's firms) and local firms that supply an intermediate input to MNCs (Sagge, 2002). In other words, when a DC has a need for some parts or items that can be made in a developing country's firm, e.g. due to lower production costs, thus such a situation requires that technology be transferred vertically (Howard and Saggi, 200). However, vertical TT refers to the transfer of technical knowledge and hardware, from R&D through to commercialisation.
- **Horizontal transfer:** This type of transfer usually occurs among developed countries, in which only technology such as tools, instruments, methods, etc. is transferred. It refers to transferred technology, e.g. plants, equipment and manufacturing schemes from one country to another. This kind of transferring can be a viable option between developed countries as they already possess advanced

knowledge whereas developing countries cannot deal with it. In the case of horizontal transfer, MNCs can transfer technology to a wholly-owned subsidiary that competes with a local firm (Saggi, 2002). Therefore, horizontal TT refers to the transfer of technical knowledge and hardware from one geographic location to another.

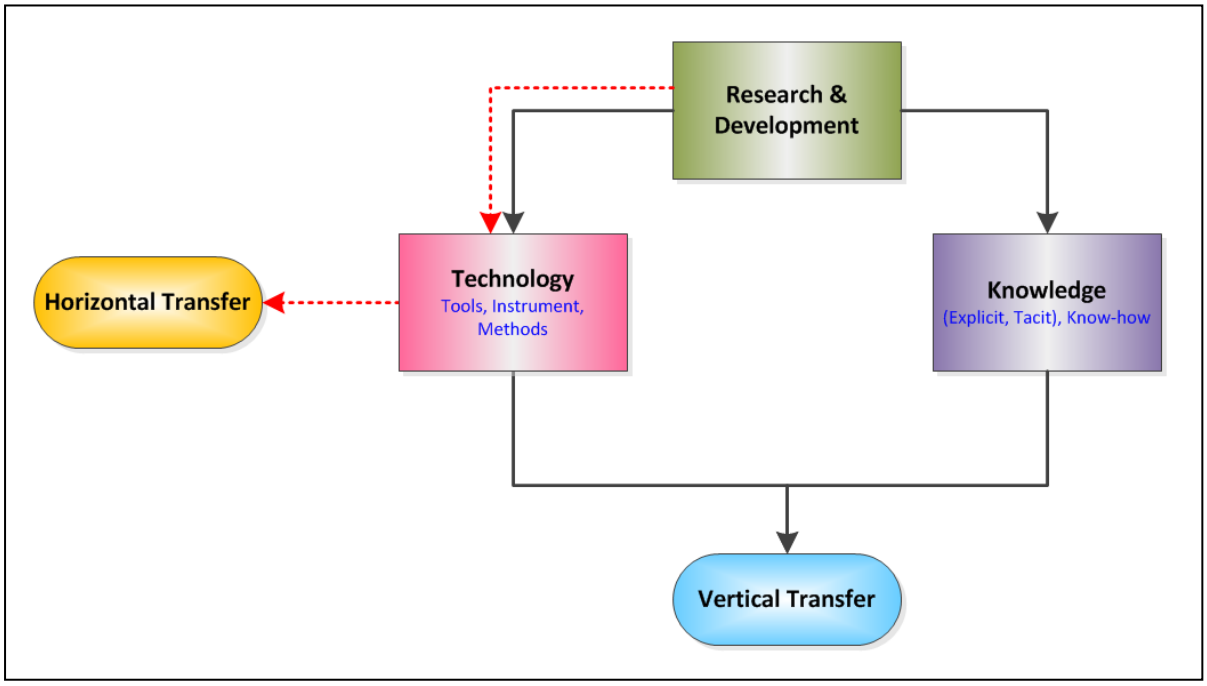


Figure 3.1: Vertical and horizontal TT

In horizontal transfer mode, equipment, devices and high-tech building can be transferred from developed to developing countries without knowledge, skills and technology transferring. This can be described as a one modern car made in a developed country and shipped to a developing one, and the people of the developing country can use and drive the car. Herein, the essential question rises, are people in the developing country then considered knowledgeable due to their ability to drive and use the car? The answer is definitely no, since they cannot make the car, and the skills of driving and using it are not enough to enable them to make their own car. The know-how and the necessary skills, education and training are acquired accumulatively in the practice of making cars. Thus, this study aims at targeting knowledge and technology transfer, not the operational transfer only.

Technology transfer usually depends on various components: need; people; willpower; a transferral mechanism; knowledge transfer fellowship; and state sponsorship. These components are described below:

- **Need:** means the real national need of the target country encouraging and facilitating effectively the transfer process. It has to be met by the transferee's environmental, cultural and traditional aspects. For instance, the transfer process cannot occur when the transferred technology does not fit the local environment in terms of sources, education level and knowledge gap, and economic circumstances (Li-Hua, 2000; Garrick, 2001; Ofori, 1994). If required sources are not locally available, it will not be economically feasible, and if the education level is not of a sufficient standard and the knowledge gap is high, the transferred technology cannot be absorbed by local employees.
- **People's willpower:** is one of the essential components within the TT process. If local people are not willing to adopt the transferred technology, this will affect whether the technology catches on, whereas if people are willing and eager to learn new technology this will aid its adaptation, spread and innovation.
- **Transferral mechanism:** this has two paths: vertical and horizontal transfer. This was discussed earlier, however, in the case of a developing country such as Iraq, vertical transfer can be considered an inevitable means for the transfer of technology (Saggi, 2001). This was made very clear in the previous experiment of precast technology between Iraq and Finland, with the precast factories being transferred into Iraq within turnkey contracts without training local employees.

  It can be argued that the fundamental problems facing developing countries in TT are the shortcomings of the settlement, along with technology development. Therefore, these countries often depend on ready-to-transfer technology without taking into account the extent of absorption capacity and development. In addition, in this regard there is another aspect of ignoring the sources of national technology leading to the process of TT taking on a narrow dimension limited to the purchase of machinery and equipment and the use of productive capacities transported, which leads to a greater reliance on advanced industrial countries and deepens the technological dependence of these countries.
- **State sponsorship:** countries facing significant challenges, especially those that have recently emerged from war or that are facing conditions related to the international

political situation, and as a result of the inevitability of pretending to change the economic policy of the country, often require a political decision and a bold veteran appointed by the government who is not subject to veto or bargaining or even debate, such as the resolution adopted by the Chinese Prime Minister Zhou Ziyang in 1978 as mentioned earlier.

In the case of Iraq, owing to the significant political changes that took place in 2003, where the people inherited a country whose infrastructure had been destroyed, it lacks the basic elements of infrastructure necessary for the advancement of services.

3.4 Research and Development as Enablers for Technology Transfer

The existing literature supports the view that technology research and development (R&D) constitutes an efficient means of international TT (Carlsson 2006). Furthermore, the evidence available shows that R&D-intensive foreign direct investment (FDI) has grown substantially in recent years (UNCTAD 2005).

Hence, foreign-controlled subsidiaries are now seen by most governments in developing countries as a central player in national innovation systems, and competition among regions and countries for internationally-mobile R&D has grown accordingly (Mudambi 1999; 2005). The location decision is a multi-faceted and heterogeneous process that depends on the nature of the R&D activities being off-shored and on the mode of entry of the investment, i.e. on whether it occurs through greenfield investment, expansion of an existing subsidiary, or a transnational merger and acquisition (M&A). Unfortunately, existing statistics do not provide a breakdown of R&D-intensive FDI by mode of entry, but previous research suggests that R&D-intensive FDI occurs mainly through the expansion of existing subsidiaries rather than through greenfield investments, at least in developed countries (e.g. Erken et al. 2005; Mudambi 1999; 2005; UNCTAD 2005).

However, there are a number of reports by international organisations that analyse success factors and try to increase our understanding of the commercialisation of university research. Most of the international studies are benchmarking exercises that focus on different aspects of knowledge and TT. The study by the European Commission (2001) concludes that the relations between the industry–research communities are largely determined by the structural features of a national innovation system. Collaborative research and personnel mobility are frequently highlighted as important factors that strengthen transfer. Bjerregaard (2010), states

that many of the collaborating researchers experienced an institutional convergence constituting a shared cultural space for knowledge exchange and communication in their joint projects.

Furthermore, the balance between TT and other goals such as education and research has to be taken into account. Other factors that are regarded as having a positive impact on knowledge and technology transfer are the establishment of joint research programmes that promote direct collaboration between industry and universities, a competition-based approach for allocating funding, and the provision of supportive infrastructure (Sellenthin, 2009). In addition, among the factors related to the host country the empirical evidence available suggests that the main location drivers are the availability of world-class research infrastructure and skilled labour (EIU 2004), as well as the dynamism of the national innovation system, i.e. the degree of interaction and collaboration among firms, universities, research centres and industrial associations (Chaminade and Vang 2006). The author of this study agrees to some extent in the case of Iraq, due to it being a developing country, and owing to its current circumstances investment activities need to take place by building new precast factories, together with the expansion and rehabilitation of existing precast factories built in 1979 by Finnish companies, e.g. Lohja corporation (Rudus), which will consequently lead to R&D activities being undertaken.

In addition, joint research activities between Finnish and Iraqi educational institutions can be prominent enablers for enhancing the industry-science-based strategy. Also, it is worth mentioning that, according to statistics collected by the Iraqi Ministry of Housing and Construction and the Ministry of Planning and Development, the demand for housing projects in Iraq is estimated to exceed three million housing units, and it is clearly beyond the ability of local firms to undertake such huge projects (http://www.imariskan.gov.iq). However, the size of the market is also a relevant attraction factor, in particular for market-seeking (or asset-exploiting) R&D-intensive FDI, which aims at adapting the product or the production process to the local context (Mansfield et al. 1979; Saggi, 2002).

3.5 Key Factors behind Technology Transfer

For TT to be a viable and effective process in terms of construction projects it has to take into account the following five key factors: technology to be transferred; knowledge acquisition; transfer modes; local staff training; and the role of humans for TT (Saad, 2002, Waroonkun, 2007, Simkoko 1992, Li-Hua, 2000).

3.5.1 Technology to be Transferred

Technology may be transferred between persons, between part of an organisation, between organisations, from a research centre or educational institution to industry, and between countries. In its most common usage, TT refers to formal and direct arrangements based on an agreement between a buyer and a seller or a non-commercial arrangement between a donor and a beneficiary. Technology transfer is not about providing the recipients with a solution to specific problems (Wallender 1979; in Ofori 1994). UNCTAD (1990a) and Andrews (1992) suggest that efficient TT occurs when technology is requested, transmitted, received, understood, applied, diffused widely and improved. Hoffman and Girvan (1990), in Saad (2002), suggest that TT needs to be understood in terms of achieving three core objectives: the introduction of new techniques by means of investing in new plants; the improvement of existing techniques; and the generation of new knowledge. This definition, in terms of production and technical details, is also echoed by Stewart and Nihei (1987), in Saad (2003) who regard technology as an innovation which is associated with new and better ways of achieving economic growth and development. Technology is also delineated in terms of knowledge and skills necessary for a specific task, such as utilising a production technique or making a specific product. Technology is therefore a whole range of knowledge, skills, ideas, equipment and facilities that organisations need to produce goods and services. It is a blending of ‘hardware’, ‘software’, ‘brainware’ and ‘support net’ (Saad, 2003) as illustrated in Figure 3.2.

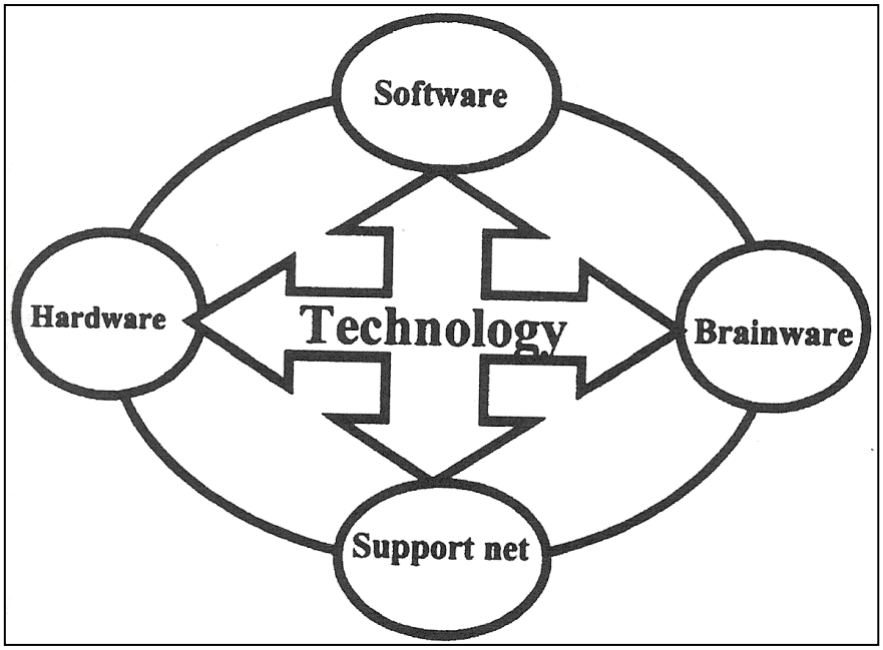


Figure 3.2: The main concepts of technology (Saad, 2003)

Hardware is merely related to the physical equipment, usually an artefact, the structure of its components and its layout. *Software* is about the 'know-how' needed for accomplishing a specific task. *Brainware* is more complex as it includes the necessary knowledge and understanding related to the application and justification of hardware and software deployment. It is also known as the 'know-what' and 'know-why' of technology. *Support net* comprises the complex network needed to support the effective use and management of the technology.

The main aim of vertical TT is to effect technological development in developing countries. Owing to the pressing and varied developmental needs of developing countries, they often have to import some construction capacity (Drewer 1980). Assembly techniques are often emphasised, and the transfer of other aspects of construction technology is important (Wesley 1987; in Ofori 1994). Construction technology involves all aspects of the building process as well as many aspects of management. For instance, while site techniques may be project-specific, managerial expertise can be applied widely over a long period and would enable effective use of all technologies. The complexity of construction technology (advanced architectural and engineering design; construction methods; management techniques; and technology, etc.) must be considered during the TT process (Calantone *et al*. 1990; Lin and Berg 2001; Simkoko 1992). Thus, Kirpich (1987) and Rosenberg (1990) suggest that priority should be given to the improvement of managerial capability in developing countries.

Construction technology embraces the material, plant and equipment, organisations, procedures and information systems used in planning, designing, constructing, maintaining, repairing, altering and demolishing of buildings and infrastructure. Construction technology development involves both imaginative solutions to specified problems and the development of alternatives to existing materials, methods and so on.

Simkoko (1990) has suggested that one of the principal objectives of commissioning or undertaking construction projects, particularly for clients in developing countries, is that the projects might facilitate the technology-acquisition process. The technology transfer and acquisition process enables clients, firms and institutions in developing countries to master, adapt and further develop the acquired design and construction technologies and management techniques. Consequently, the technology-acquisition process is regarded as one mechanism for building up missing technological and managerial competence within firms in developing countries (Simkoko 1989).

Studies (UNIDO 1980; UNCTAD 1990a; Stewart 1991; in Ofori 1994) show that, by any of the standards used to measure a country's technological development (number of research and development (R&D) personnel, aggregate R&D expenditure, volume of manufactured exports, share of high-technology services, and number of international patents owned) there are large and growing disparities between industrialised and developing countries. The appropriateness of some of these measures may be disputed. For example, a country's volume of export is influenced by many factors including access to markets. However, developing countries are technologically dependent on industrialised ones; they import elements of a wide range of technologies. Construction is closely related to many sectors of the economy. The technological weakness of developing countries is attributable to many factors with varying influences in individual countries.

The technological development of construction industries in developing countries is still relatively low, both in comparison with their counterparts in industrialised countries and considering their present and future tasks. This is perhaps most evident in their failure to use their countries' resources, leading to a huge volume of unmet needs and high construction costs. While inadequate technology is not the only, nor the main problem facing these industries, upgrading their level of technological development can nevertheless help improve their performance (Ofori 1991b).

3.5.2 Knowledge Acquisition

Knowledge is a key element of the TT process, since technology cannot become widespread unless it is enhanced by knowledge transfer.

Philosophical debates in general start with Plato's formulation of knowledge as 'justified true belief'. There is currently, however, no single agreed definition of knowledge, nor any prospect of there being one, and there remain numerous competing theories. This is because there is a multiplicity of doctrines for understanding knowledge. Therefore, the difference in understanding of knowledge is obvious among philosophers. Some of them perceive that rationalism is the main route to knowledge, while others see it instead as empiricism.

However, the German philosopher Immanuel Kant argued that knowledge arises only when both the logical thinking of rationalism and sensory experience of empiricism work together (Kant, 1999).

Knowledge acquisition involves complex cognitive processes: perception, learning, communication, association and reasoning. The term knowledge is also used to mean the confident understanding of a subject with the ability to use it for a specific purpose if appropriate.

Nonaka and Takeuchi (1995) classify human knowledge into two kinds. One is *explicit knowledge*, which can be articulated in formal language including grammatical statements, mathematical expressions, specifications, manuals, and so forth. This kind of knowledge thus can be transmitted between individuals formally and easily. This has been the dominant mode of knowledge in the Western philosophical tradition. However, they also argue that a more important kind of knowledge is *tacit knowledge*, which is hard to articulate with formal language. It is personal knowledge embedded in individual experience and involves intangible factors such as personal beliefs, perspectives, and value systems (Koskinen *et al*., 2002). Tacit knowledge has been overlooked as a critical component of collective human behaviour. Tacit knowledge, due to its non-codifiable nature, has to be transferred through 'intimate human interactions' (Tsang, 1997; in Li-Hua, 2000). Herein, the role of expatriates (Finn-Iraqis) represents a key player to facilitate these interactions.

In Japan, for instance, the Japanese consider tacit knowledge an important source of their companies' competitiveness. This is probably a major reason that Japanese management styles are viewed as somewhat of an enigma among Western people. In contrast, in Western

philosophy, the individual is the principal agent who possesses and processes knowledge. However, Nanoka and Takeuchi show in their study that in organisational knowledge creation consists of two major components: the individual interacts with the organisation through knowledge and the forms of knowledge interaction. The two forms of interaction between tacit and explicit knowledge and between the individual and the organisation bring four major processes of knowledge conversion, which together constitute knowledge creation Figure 3.3:

1. from tacit to explicit
2. from explicit to explicit
3. from explicit to tacit
4. from tacit to tacit

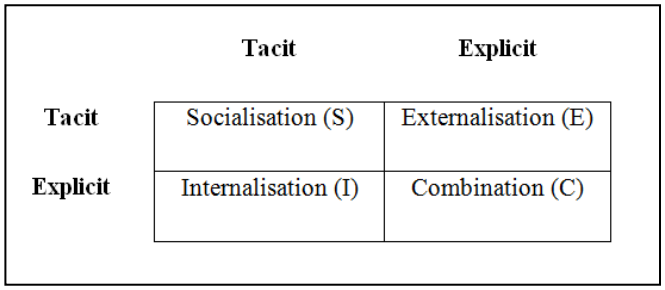


Figure 3.3: Knowledge Creation Theory (Nanoka and Takeuchi, 1995)

Organisational knowledge is a mixture of tacit and explicit knowledge. Tacit knowledge is stored in individuals' heads .It is a product of experiences, insights and intuition which could be technical (i.e. the know-how of an expert) or cognitive (i.e. based on values, beliefs and perceptions). In the context of construction, examples of tacit knowledge include estimating and tendering skills acquired over time through hands-on experience of preparing bids, understanding the construction process, interaction with clients/customers and project team members in the construction supply chain, as well as understanding tender markets (Egbu and Robinson, 2005).

This type of knowledge is experiential, judgmental, context-specific and therefore difficult to codify and share. Explicit knowledge is stored as written documents or procedures. As this type of knowledge is codifiable, it is reusable in construction including design codes of practice, performance specifications, drawings in paper-based or electronic format and construction techniques. Materials testing procedures, design sketches and images, 3D models and textbooks are also examples of explicit knowledge.

Construction project knowledge is created through the actions of individuals, project teams and construction organisations, and the interactions of these different types of knowledge (explicit and tacit) from concept design to handing over of the completed project.

Tacit to tacit interaction takes place through the process of socialisation. An architect giving a verbal account or an explanation of a design concept to a client during a meeting is an example of this form of interaction. Apprentice carpenters, bricklayers, plumbers, etc. often work with their masters to learn craftsmanship not through formal instruction but by socialisation which involves observation, imitation and practice. The long tradition of apprenticeship schemes in the construction industry is responsible for producing numerous artisans who rely on their tacit knowledge to solve construction problems. Such experiential knowledge is reinforced and developed through shared experience by continuous interaction and learning from each other.

Internalisation takes place when knowledge is transferred from explicit to tacit by individuals. For example, an architect reading a textbook on design theory, or using a manual on design standards, could interpret these explicit documents to create an internal mental model of a unique design satisfying the client's requirements and his/her taste and style.

Externalisation is the reverse process whereby tacit knowledge is made explicit so that it can be shared. An architect engaged in a discussion with a contractor on site, which is subsequently followed by a written instruction made available to specialist subcontractors, engineers and quantity surveyors, is an example of an externalisation process. This process also takes place when an architect translates a design concept or mental model into sketches to explain to a client.

Explicit to explicit knowledge interaction takes place through a process called *combination*. Combination involves gathering, integrating, transferring, diffusing and editing knowledge (Nonaka and Toyoma, 2003; Robison and Egbu, 2005). Individuals and project teams in construction create knowledge through integrating and processing various project documents (e.g. design brief, sketches, project programme, engineering and production drawings, performance specifications, conditions of contract, bill of quantities). Technologies such as e-mail, databases, CAD systems, document management system and project extranets facilitate this mode of knowledge conversion. Various other technologies and techniques are used to facilitate other knowledge conversion processes, such as face-to-face interactions, communities of practice, project review meetings, brainstorming sessions and 'toolbox talk'

on site. Much of the training and experience of construction professionals is based on a balance between codified (explicit) and tacit knowledge.

Tacit knowledge is based on 'learning-by-doing' which can be included within a joint venture agreement. This is in contrast to turnkey projects which exclude such commitment to facilitate tacit knowledge acquisition. Thus, turnkey projects were one of the main failure-causing factors in the Algerian TT process (Saad, 2002), after which was noted the need to adopt a reform plan that included the learning-by-doing approach and local labour involvement. In contrast, turnkey contracts can be better suited to developed countries due to the possession of advanced knowledge and technology.

3.5.3 Transfer Modes

The transfer mode is principally a type of contractual agreement agreed by both parties: transferor and transferee. The contractual agreement type (e.g. joint venture) might be for the project and its implications for the TT process (Calatone *et al.*1990; Ganesan and Kelsey 2006). The type of contractual arrangement between two parties is a key to allocating risk and responsibility for all aspects of the project (Ganesan and Kelsey 2006). If too much risk is allocated to one party their intent to participate may be greatly reduced. However, the construction mode of transfer adopted on the project can influence the degree to which TT performs.

Saad (2003) stated that the introduction of new and advanced technology in developing countries is unlikely to succeed unless the approach and the organisational context are modified. This approach must take into account the limited availability of technological knowledge and information and the vast number of social, organisational and economic features which can make it difficult or impossible to replicate off-the-shelf, organisational design or technology previously developed and used in industrialised countries.

Typically, construction projects incorporating TT are procured by turnkey systems, direct licensing agreements, management contracting or joint ventures. For larger and/or complex TT projects, alternative modes may be adopted such as licensing-cum joint venture, turnkey-cum-licensing, etc. (Calantone *et al*. 1990).

In developed countries the turnkey approach can succeed due to the existence of the principal knowledge, in contrast to developing countries that lack such knowledge. This can be seen very clearly in Algeria and Iraq when they adopted turnkey contracts with TT programmes that took place between 1970 and 1990. Algerian professionals noticed after a period of time that the turnkey contract was not suited for TT projects because of the lack of involvement of local staff in all stages of implementation, ranging from design till operation and maintenance.

In Iraq, the TT process was not followed up because of the political conditions suffered by prolonged wars. Nearly all of the plants, factories and stations belonging to these projects were plundered and looted as well as neglected by the State because of the prevailing circumstances and the unstable political situation in the country.

Saad (2002) stated that transfer has three distinguishable modes: (1) materials, final products, components, equipment and turnkey and /or 'product-in-hand' plants; (2) designs, blueprints and the 'know-how' which provides the basic information, data and guidelines needed to create a desired capability; (3) the 'know-why' and software needed to adapt existing technology and to innovate. Carrillo (1996) stated that UK construction companies (e.g. Costain corporation) considered teamwork on an integrated joint venture to be the best way of transferring technology, and both partners were therefore said to have learnt 'on-the-job'.

Technology transfer on construction joint ventures may take various forms which may be classified into formal taught courses, hands-on training or a combination of both methods (Carrillo 1993). The ILO (1987) has also pointed out the importance of training within the construction industry. Technology was transferred in 'learning by doing' during the construction process in North Africa and South East Asia.

Carrillo (1996) has shown that in the majority of cases 'learning by doing' is used for skilled craftsmen, while professionals such as engineers and managers are sent on courses, both locally or on study visits to the donor countries. Ofori (1994) says that training packages are often included by developing-country governments and/or donors in contracts involving foreign companies. Governmental level arrangements may involve a medium-term programme of technical assistance. Roger (2007) stated that joint ventures between international and local construction companies (CCs) are then possible and local personnel are able to assimilate the transferred knowledge to a higher degree. In contrast, if the host country has proceeded with development and has local contractors and construction

companies that can absorb knowledge from suppliers originating in developed countries and knows how to learn from its own experiences, a turnkey contract is often an inferior mode (Roger 2007).

In turnkey projects, the learning-by-doing effect is more likely to be almost exclusively appropriated by suppliers from developed countries that become more competitive in tendering for subsequent contracts in other countries (Roberts 1972; in Roger 2007). In fact, 15-20 years ago, contractors and construction companies from developed countries could sell their services in a turnkey project and then continue to the next project and sell the same services. Sometimes they could even return to an old client and sell similar services a second time. However, some scholars observe that the time and resources required to transfer technology depend on, among other factors, the mode of transfer (Baranson 1976; in Ofori 1994).

3.5.4 Local Staff Training

Training is essential in the TT process due to the fact that it reinforces knowledge and technology to transferee staff. This can occur according to the nature of transferred knowledge and technology either by conducting training courses at different levels or by involving local staff in implementing construction projects. Moreover, sending local staff to construction sites and construction factories in a transferor country can be beneficial for the practical experiences gained that enable them to perform similar project independently in their own developing countries.

3.6 Future Prospects for Technology Transfer

Transfer of technology has evolved, and it is still evolving as a result of the dynamic requirements occurring in the world. For instance, economic developments, shifts in economic policies and the desire of nations to improve their living standards, the overall economic status, and their scientific and technological skills, have all created the need for TT manoeuvres. TT in this context refers to an intersection of several disciplines such as business, science, engineering, law and government policies. Consequently, TT can be seen as a process through which the results of fundamental research and novel discoveries in

developed countries are able to reach relevant practical and commercial applications in any developing country.

These changes can be seen, for instance, in China improving through TT projects due to effective policy changes since Premier Zhou Ziyang adopted an open doors policy announced the aim of quadrupling the gross annual value of industrial and agricultural production by involving foreign direct investment- 'we should imitate them' (San, 2004).

Noting that, in Japan the situation where the emerging of sudden appreciation of the yen and the need to find new strategies to deal with international trade conflict. This has forced Japanese enterprises seeking new and cheaper production environments (e.g. Malaysia, Singapore, Thailand and China) to cope with a new economic conflict which apparently led to the sharp increase in foreign direct investment FDI by private Japanese enterprises in 1985 which started with $10 billion annually to reach $65 billion in 1989.

Japanese enterprises have been requested to give up their technology to be transferred to the ASEAN countries (Association of Southeast Asian Nations). Current Japanese investment in the ASEAN countries is motivated also by the desire to establish export bases abroad and take advantage of low-cost labour and local government incentives (Yamashita, 1991

TT processes can be considered to be interesting key operations for developing countries to achieve economic growth. Phillips *et al.* (1994) states that host (transferee) firms applying new technology from foreign sources should achieve benefits in two dimensions: perceived utilities for the organisation; and/or perceived utilities for the individual. The benefit to the organisation usually means economic benefits resulting from adoption of a new technology which include increases in productivity, quality upgrading, cost reduction, improvement in market share, and entry to new markets (Calantone *et al*., 1988; Rogers,1983).

Benefits to an individual within the host organisation, utility is most likely the result of improved job performance and associated intrinsic and extrinsic rewards (Davis *et al*., 1989). Thus, this is crucial to the developing countries possess advanced construction industry as it is considered fundamental for the development of a world-class infrastructure.

3.7 Summary

This chapter portrayed TT as a phenomenon whereby advanced knowledge and technology originating in developed countries can be transferred to developing countries that lack the latest technology. Technology transfer rests on three fundamental pillars: (i) knowledge is understood as experiences, qualifications and skills to produce the technology; (ii) technology, the application of knowledge embedded in a product; and (iii) a transfer mechanism by which technology can be transferred to be diffused from place to another.

The anatomy of TT involves two fundamental characteristics of transfer, which are the vertical transfer mode, in which knowledge and technology are transferred effectively from a developed country to a developing one, and horizontal transfer mode in which the TT occurs from a developed country to another developed country where a substantial level of knowledge exists.

CHAPTER 4

HUMAN-CENTRIC DIMENSIONS IN TECHNOLOGY TRANSFER

4.1 Introduction

This chapter highlights the core concept of this study, which is the human role in the TT process. A human being, on one hand, can be a skilled individual and professional in performing tasks, and on the other hand, can expand the circle of such experts. For the needs for expansion, skilled people need to train and educate other people, so that they will in turn help them to fulfil their duties and tasks. Hence, the need for knowledge transfer and acquisition raises the question of for whom, how and when the knowledge and TT process can be efficient and successful. Further, this chapter will define the role of the migrant community (diasporas) as potential Knowledge and Technology Integrators between transferor and transferee.

This chapter starts by describing the roles of humans in TT. Next, it identifies the potential skills of humans in the TT process, including the skills of bilingual, bicultural and technology experts. It then goes on to discuss the relationship between the transferor and transferee. Finally, the chapter identifies two major factors that affect the performance of humans in TT, which are training and the willingness and ability to learn.

4.2 Role of Humans in Technology Transfer

Humans are considered to be conductors between all other parts within the overall TT process. They may have abilities that enable them to receive, send, communicate and modify knowledge and skills. In other words, humans can be seen as vehicles to transfer and to obtain knowledge. In this study, a human is like an *expatriate* (in abbreviated form, *expat*) who is a person temporarily or permanently residing in a country and culture other than that of the person's upbringing or legal residence. The word comes from the Latin *ex* (out of) and *patria* (country, fatherland).

In its broadest sense, an expatriate is any person living in a different country from where he or she is a citizen. For instance, in Dubai the population is predominantly comprised of expatriates, from countries such as India, Pakistan, Bangladesh and the Philippines, with original citizens making up only 20% of the population (Mahdavi, 2011). In common usage, the term is often used in the context of professionals sent abroad by their companies, as opposed to locally hired staff (who can also be foreigners). The differences found in common usage usually comes down to socio-economic factors, so skilled professionals working in another country are described as expatriates, whereas a manual labourer who has moved to another country to earn more money might be labelled an 'immigrant'. There is no set definition and usage varies according to context and individual preferences and prejudices (Leonard, 2010).

It is necessary to explain how the terminology ‘diasporas’ was chosen for this research. Initially, the term ‘expatriate’ was suggested to be used. The literature conducted has showed that there is no specific definition for term expatriate. It has been noticed the differentiation and conflicts among researchers and writers who used this term in wide context. However, the term expatriate reflects the individual’s sense depending on understanding the context used by every single writer. In the literature of this study, the definition of expatriate can be summarised as the individuals who are qualified with latest high education and having efficient experiences of modern technology. Moreover, they are fluent in both transferor’s and transferee’s languages. For instance, Finn-Iraqis hereinafter are a good example of diasporas. To distinguish the particular mission of such expatriate individuals in the TT process context, this study suggested to choose the term *diasporas* as an alternative to the generic term *expatriate*.

4.3 Human Skills in Technology Transfer

Migrant groups who permanently settle in another country, gain citizenship and obtain qualifications from educational establishments from the host country are considered to be diasporas. This group becomes bicultural and bicultural with both the original and the new host culture and language.

The next two subsections will identify the human skills that affect TT process and then it will present some success stories of BBTs.

4.3.1 Identifying the Human Skills Affecting

This study is focusing on three main human skills that can be utilised to improve the TT process effectively. These three skills are ***bilingualism, biculturalism and technological expertise.***

Bilingualism

Bilingualism refers to the ability to speak two languages conversationally to some level of proficiency. In other words, a person who masters two languages or more is known as a bilingual or multilingual person. A bilingual person can communicate either actively (through speaking or writing) or passively (through listening, reading or perceiving) (Bialystok, 2001). A generic term for multilingual persons is polyglot. Poly means 'many', glot means 'language' (Oxford Dictionary: Polyglot).

Multilingual people have acquired and maintained at least one language during childhood, the so-called first language. The first language (sometimes also referred to as the mother tongue) is acquired without any formal education by mechanisms that are heavily disputed. Children acquiring two languages in this way are called simultaneously bilinguals. Even in the case of simultaneous bilinguals one language usually dominates the other (Chin, 2007).

- **Biculturalism**

Being bicultural means cultural knowledge and coexistence in the context of two or more cultures and knowledge of the mentality and mode of thinking of the individuals is an

important factor to avoiding unforeseen and potential problems. Furthermore, diasporas can inherently strengthen relationships between Finnish and Iraqi managers and all employees involved in cooperative practice (e.g. joint venture projects) due to their understanding of both cultures.

Therefore, the involvement of diasporas, who possess skills and Finnish qualifications, within the TT process enables knowledge and technology to flow between Finns and Iraqis. Thus diasporas involvement in TT implies two transfer dimensions: firstly they can be conductors of knowledge and technology transfer from Finns to Iraqis (local staff); and secondly they are able to train local staff by themselves independently from Finns. In terms of making the TT process efficient, diasporas play an integrating role between Finns and Iraqi local staff.

- **Technological Expertise**

Technological expertise covers the cumulative expertise and skills that are built up while working with qualified staff and adapting and acquiring new knowledge and techniques that qualify the individual to become proficient in technology use. This cumulative expertise can be transferred by the individual to other individuals in the same community (internal transfer), within an organisation, or internationally to other countries (horizontal and vertical transfer).

4.4 The Relationship between Transferor and Transferee

Human relationships are essential in strengthening ties between the transferor and transferee, especially in the construction TT process. The benefits of strong personal relationships include improved communication and reduced conflicts, leading to the trend seen in developed countries to use multicultural teams. For instance, in Finland, many companies have recently started to use multicultural project teams for new purposes (Mäkiluoko, 2003). As for communication, as it is one of the essential factors that enhance human relationships, it has caused tension between Finns and Americans, since models of communication are different between Finns and Americans. Finnish communication may be seen by Americans as tough and abrupt. As a result, they may have appeared unpleasant, harsh and even

insulting. One reason suggested for this was their language skills, i.e. some Finns apparently did not master polite forms of the English language (Mäkiluoko, 2003). The following quotation shows one person's perception of communication differences within a team:

> *'They say Finnish people are direct... I think we are a little more political. More political if someone does a bad job... I have worked with the Finns for a long time so I am used to them. I have learned to appreciate a lot of the things they do. At first it is harsh, but then I saw the effectiveness of it (American team member)'.* (Mäkiluoko, 2004).

As for Chinese culture, it has been found that the conditions of contract have a limited impact on project performance. Instead, project prehistory and prior working relationships have the most impact on project culture (Rowlinson and Root, 1997, in Ofori, 2003). Furthermore, Hall and (Jaggar, 1997, in Ofori, 2003) have suggested that key elements of culture should be understood, appreciated and incorporated into procurement arrangements.

Fragmentation has been recognised as a characteristic of the construction industry (Latham, 1994). Hence, there is a need for other industry firms to be integrated within construction projects. Therefore, knowledge and technology integrators may act here as mediators between transferor and other local small firms that can be expected to perform small tasks (e.g. plumbing), or any other work needed.

Accordingly, it can be concluded that the target group in this study, i.e. diasporas, are key players in solving and smoothing out potential conflicts that may occur due to misunderstandings of culture, tradition or language.

4.5 Factors Affecting Human Performance in TT

There are two main factors that affect human performance in the TT process, which are training factors and their willingness and ability to learn. These two factors will be described below.

4.5.1 Training

Training is a significant factor that affects the human performance in TT operations. The word *training* refers to ‘organized activity aimed at imparting information and/or instructions to improve the recipient's performance or to help him or her attain a required level of knowledge or skill’ (The Business Dictionary). Carrillo (1994) emphasised that TT training programmes should be considered as a priority for successful TT process. For instance, the Korean government embraced a successful TT strategy in manufacturing industry towards foreign investments. The government ensured that the local staff training is a clearly specified requirement in contracts and made certain that the terms of the contract in this context were fulfilled (Carrillo, 1994).

According to the literature made in investigating the relationship between training and TT, training can be classified into three categories. These three categories are:

- training for transferee local staff in their homeland;
- training for transferee local staff in transferor country; and
- training for transferor diasporas who are to work in transferee country.

The United Nations Conference on Trade and Development organisation (UNCTAD) is the UN department that promotes the development-friendly integration of developing countries into the world economy. UNCTAD has conducted an international survey in its efforts to support facilitating TT by identifying the existing home-country measures that encourage TT in various modes to developing countries. These measures include financial support, training, matching services, partnerships, and products purchase, licensing, and intellectual property (IP) right protection. The survey was designed to target 41 agencies and programmes in 23 developed countries that offer measures facilitating TT. 19 of the surveyed agencies offer training programmes for local staff/workers in developing countries. Table 4.1 shows the summary of the survey (UNCTAD 2004). This part of the survey refers to providing training to local staff in their homeland by experts from developed countries.

The UNCTAD survey also covered the Japan International Training Organization (JITCO), which is an organisation established in 1991 under the joint authority of five Japanese government ministries: Justice; Foreign Affairs; Economy, Trade and Industry; Health, Labour and Welfare; Land, Infrastructure and Transport. In its goal to transfer technology to developing countries, JITCO’s strategy is to invite foreign workers to undergo training at

Japanese companies. JITCO helps identify Japanese firms that can provide training for foreign trainees. The training programme is provided for a period of one year. Within the period of training, trainees spend one-third of the time in off-the-job training and two-thirds in on-the-job training. Furthermore, trainees may obtain an extra year to master the industrial technology, skills and knowledge that will be of the interest of their countries (UNCTAD 2004). The JITCO experience represents an interesting example of providing training for transferee local staff in transferor country (i.e. Japan in this case).

The University Companies Association (UNICO) is a technology transfer organisation established in 1994 to represent the technology utilisation companies of UK universities. UNICO estimated in 2006 that there are approximately 1,200 TT professionals in the UK working in academia, industry and consultancies. The figure is rising at an estimate of 20% per year. These figures have attracted researchers to investigate this phenomenon and how to commercialise it. Questions were arisen such as how TT professional learn the required skills to improve their performance while abroad, how to utilise networking opportunities that can help their professional development. There have been several training courses offered by organisations to provide the skills needed that target new TT professionals who are in the job for six months or less. For instance, PraxisUnico is a leading organisation in TT training in the UK, which encourages innovation and research commercialisation profession, and facilitating the interaction between the public sector research base, business and government (Phillips, 2006).

4.5.2 Willingness and Ability to Learn

New knowledge and technology can be absorbed and settled by a transferee's local staff when the will exists to learn and acquire new technology. Human willpower is one of the essential components within the TT process. If local people are not willing to adopt the transferred technology, this will affect the uptake of that technology, whereas if people are willing and eager to learn new technology, this helps towards adaptation, uptake and innovation. In the case of knowledge transfer to emerging markets via TT, the lack of absorptive capacity can represent the largest transfer cost (Svensson, 2007) due to spending huge amounts of money on direct investments (Janssen, 2010). The training of local personnel should be the best element to include in projects to facilitate knowledge transfer to the transferees and to increase their absorptive capacity.

Table 4.1: Summary of some Home-Country Measures facilitating technology transfer, where *TOT* = Transfer of Technology (refers to TT in our study); *FDI* = Finance Direct Investment, *PPP* = Public-Private Partnership (UNCTAD 2004)

Country	Agency	Financing TOT	FDI	Matching	PPP	Training	Venture capital
Australia	AADCP				●		
	ACIAR	●				●	
Austria	Buerges Bank		●				
Belgium	SBI-BMI		●				
Canada	CIDA-TTF	●			●	●	
	CIDA-PPI	●				●	
Denmark	DANIDA-PSD				●		
	IFU-IO		●			●	
	MCP	●				●	
European Union	RIET			●	●	●	
Finland	FINNFUND		●				
France	PROPARCO		●				
	IRD					●	
	FGEF+						
	CIRAD					●	
Germany	GTZ-PPP			●	●		
Iceland	ICEIDA	●				●	
Ireland	Enterprise Ireland		●				
Italy	SIMEST		●	●			
Japan	JETRO					●	
	JITCO					●	
	JAIDO		●				
	JICA	●			●	●	
Netherlands	FMO		●	●		●	
	PSOM		●		●		
New Zealand	NZODA		●			●	
Nordic countries	NORSAD			●			●
Norway	NORAD					●	
	NORAD -SA/SL/In			●		●	
	NORFUND						●
Portugal	ICEP-APAD		●				
Spain	COFIDES		●				
Sweden	SWEDEFUND						●
	SIDA				●	●	
Switzerland	SECO-SDFC		●	●			
	SOFI-SSF		●	●			
United Kingdom	CDC						●
	DFID				●	●	
	JEMU-TPI			●			
USA	USAID-GTN			●			
	USAID-Leland	●				●	

4.6 Summary

This chapter dealt with the human factors involved in TT, which is the topic of this study. The focus in this study is on the human-centric factors that, in turn, play the role of a catalyst to create an appropriate environment which makes for a smooth TT process. Therefore, Iraqis living in Finland who hold Finnish qualifications are seen as KTI within the TT process. Such KTIs may possess exceptional skills that enable them to perform and facilitate the TT process. Finally, this chapter shed light on the learning and absorptive capacity of local personnel as one of the essential elements in enhancing the TT process as a whole.

CHAPTER 5

RELATED WORK

5.1 Introduction

The benefits of implementing advanced construction technologies in developing countries can be quite significant. It seems that the optimal approach for TT between developed and developing countries is the vertical approach that ensures the transfer of knowledge side-by-side with technology in the TT process. There have been several attempts to introduce best-practice models for vertical TT. This chapter aims at providing an extensive literature review of the existing vertical TT models. The review of existing literature and related work identifies the limitations in the current understanding of the TT process that can be further explored. Reviewing related work in the subject area is an essential step to ensure that the research undertaken considers previous attempts to resolve the research problem and develops the anticipated solution based on the limitations of the current/existing solutions.

This chapter starts by providing a general overview of the related work in TT. This will be followed by identifying and describing four TT models, including the Extended TT Project Life Cycle Model (ETT-PLC), Technology Acquisition Model (TA), Incorporating Tacit Knowledge Model (ITK), and Value Added Model (VA). These four models will then be thoroughly discussed and evaluated to highlight their strengths and weaknesses. Finally, the evaluation of the four models will in turn reveal the potential options for designing a new TT model that can resolve the weaknesses and limitations of the related work by integrating more advanced factors and features.

5.2 Overview of Related Work in TT

Due to the recent economic situations in developing countries, international TT is debated as an important and controversial issue in the world economy (Calantone, 1990). The importance of international TT in the world economy arises from its ability to provide developing countries with new technology that can improve efficiency and hence contribute to world economic growth (Yamashita, 1991). There has always been a strong interrelationship between politics and national economies. Political sciences focus on the pursuit of interests through the impact of government decisions, decision-making methods and implementation policies (Saad, 2000). Therefore, politicians are encouraged to improve their countries' economies by pushing for appropriate approaches to achieve a satisfactory economic growth level. This can occur by importing the latest technologies in order to improve marketing and managerial skills, local labour skills, expertise and performance. TT projects are geared for such tasks, including hiring diasporas, international joint ventures and learning-by-doing. According to Dunning (Schonberger, 1984), the important missing elements of development in developing countries are the 'acquisition of knowledge, R&D techniques, production technology, and marketing and managerial skills'.

On the other hand, in the case of the global financial crisis and increasing the rate of currency was concerned with the degree to which the global economic and currency volatility impose government, investors and bankers to work with emerging economies, which have a lot of credit, liquidity and appropriateness of the market environment. For instance, in Japan when the rate of the yen reached its highest rate in the early 1980s, Japanese products became less competitive internationally. Therefore, there was a need to develop new strategies to deal with international trade conflicts. Disagreements with other countries over trade practices have forced Japanese companies to look for production sites abroad. Consequently, investment by Japanese firms headed to Southeast Asia. Current Japanese investment in the ASEAN countries (Association of Southeast Asian Nations) was also motivated by the desire to establish export bases abroad to take advantage of the low-cost labour and local government incentives (Shoichi 1991). Moreover, the ASEAN governments have changed their policies to actively attract foreign investment, offering export-oriented foreign-capital business by exempting corporate taxes and importing duties as well as other privileges.

However, in the past three decades many developing countries have undergone unprecedented changes in the construction sector. There has been an increasing realisation that management and technical capabilities can be improved through TT initiatives with

foreign firms (San, 2004). To do so, the process of international TT is considered to be an effective way of obtaining necessary resources and technology, such as management resources, construction technology, and construction resources (Waroonkun, 2005b).

The implementation of international construction technology into developing countries is a complex process that is influenced by factors including the following:

- the host country's policies and economic situation;
- the need for transferred technology as a stock;
- the TT environment;
- the learning environment, which is linked to the degree to which government policy can attract qualified diasporas; and
- ways to sponsor an appropriate TT programme capable of bridging the existing knowledge gap and to encourage investment laws to create an appropriate climate.

The next section will present four models of the TT process, which will be used in the next chapter to propose a new solution for this research.

5.3 Technology Transfer Models

Many researchers have studied the TT process and a number of international TT models have been developed. However, whilst many of these models were developed for the business and manufacturing sectors, there are common concepts and factors that they all share. This study has reviewed various TT models that have been proposed over the last two decades. Four noteworthy models have been chosen, which incorporate concepts and factors related to the proposed model in this research. The first model discussed (Saad, 2000), for which the case study country was Algeria, emphasises extending the traditional project life cycle model to involve TT stages. This model was chosen because of the similarities between Algeria and Iraq in terms of culture, environment, national mentality, and educational level. Moreover, policy, economic and governmental structures were equivalent in both countries. The second model (Simkoko, 1992) emphasises technology acquisition, which is considered a backbone for the main target of the overall TT process. The case study of this model considers the TT process between Sweden (as a developed country) and developing countries such as Tanzania and Kenya. This model was chosen for this study because of the similarities between Sweden

and Finland in terms of the experience of Swedish construction companies in TT projects in developing countries. The third model (Li-Hua, 2000) incorporates tacit knowledge by discussing the taxonomy of knowledge and how to facilitate the process of decoding tacit knowledge. This model was chosen due to the link between construction TT and the importance of decoding tacit knowledge. Finally, the fourth model (Waroonkun, 2007) is the value-added model, in which the focus is on the ultimate performance of local staff when they work independently. Modelling will be developed through a process of justifying, grouping, preferring and refining factors established across the above-mentioned researchers' models. Table 5.1 highlights the reasons behind choosing these four research models and the justification of these choices.

Table 5.1: The four TT research models and the justification of choosing these models in this study

#	Model Name	Acronyms	Author	Year	Justification of Choice
1	Extended TT Project Life Cycle Model	ETT-PLC	Saad	2002	Due to the similarity of the state regime (totalitarian) of both Iraq and Algeria back then, further both countries share the same culture and language. The TT was in general industry. The remarkable characteristic of this model is the focus on extending the project life cycle by operating the project by local staff who have gained skills whilst their involvement with the foreign staff during the project implementation.
2	Technology Acquisition Model	TA	Simkoko	1992	There were 12 countries chosen from Africa, South America and Asia. This variety would enrich the research resources considering the different cultural and language issues as well as the geographical distribution between transferor and transferee. The other remarkable characteristic of this model is the focus on knowledge acquisition.
3	Incorporating Tacit Knowledge Model	ITK	Li-Hua	2000	The significant feature of this model is the focus on the tacit knowledge which needs understanding the cultural and language skills to ensure effective transfer of knowledge. Also, it emphasises that the higher the economic growth the more the need to knowledge transfer.

4	Value-Added Model	VA	Waroonkun	2007	The remarkable characteristic of this model is the measure of the value- added after the project implementation phase is done. This measure is scaled by how qualified the local staff are to perform similar projects in the future.

5.3.1 Extended TT Project Life Cycle Model (ETT-PLC)

Saad *et al.* (2002) proposed to a TT model that aimed to refocus research attention in assessing TT projects based on the level of performance to better understand the TT process and its association with managerial practices in developing countries. The model was designed in an evaluation framework called the Extended TT Project Life Cycle Model (ETT-PLC) (see figure 5.1). The ETT-PLC model was used to analyse the TT process in Algeria over the last three decades. Two case studies were considered and compared based on two integrated mechanisms of TT used in Algeria between 1965 and 1990: *turnkey* and *product-in-hand*. The model significantly considers the contractual arrangements that govern TT projects. It assumes that the procurement and acquisition of *hardware*, *software* and *knowledge* are relevant to specific industrial and national cases. It also identifies a complex range of issues associated with the influence of multiple stakeholders on TT process. The complexity is further increased with the interfering of political, technological, cultural, social and organisational factors in TT process (Saad, 2001).

Algeria's strategy in the late 1960s and early 1970s was to develop technological and industrial capabilities to a high level as rapidly as possible. This desire for rapid and heavy industrialisation led in the seventies to embrace projects to purchase complex and expensive technological systems, which included highly-integrated mechanisms of TT. These projects were procured through turnkey and product-in-hand contracts (Saad, 2001).

According to the ETT-PLC model, a manufacturing plant or an engineering system can be done by a sequence of logical steps: initiation, design and development, implementation and hand-over. In a turnkey project, the technology supplier is fully responsible for the concept, design and execution stages. The supplier is in charge of making the choice of process design, as well as the selection, delivery, installation and commissioning of machinery, and the associated civil engineering and construction work. However, turnkey projects do not

include training of local managers and workers and developing their skills. Therefore, the reliance is either on outside assistance for management and skilled operations, or on inefficient operations by local staff due to the lack of understanding/skills (Saad, 2001).

The turnkey contract puts an emphasis on acquiring hardware that is seen as the only essential condition for TT. Such an approach would probably be successful in an environment containing adequate levels of skills, experience and knowledge. However, in Algeria during the 1970s, half of the workforce involved in production activities was illiterate, and there were no more than 250 engineers in the whole country (Saad, 2001).

In order to overcome these constraints and to avoid reproducing the same mistakes, Algerian firms preferred an alternative package; the product-in-hand project. The focus was shifted to the long-term objective, which is to guarantee success of the TT improving local technological capability. To do so, foreign experts were hired in the project to train local people. In spite of being an expensive form of project procurement, it integrated a panacea for avoiding the difficulties generated by turnkey projects. This integrated package has charged the technology supplier with delivering an 'extended' project to provide the necessary operating skills, training inputs and the operating organisation's structure, in addition to the design, construction and commissioning of facilities. According to the extended package, the supplier had to adapt the project concept according to local conditions and requirements, to train the local workforce, to be in charge of the initial management, and finally to offer guarantees related to mechanical aspects, installation and performance. Also, the supplier was required to provide technical assistance towards integrating local components. This approach allowed Algerian state-owned organisations to achieve their goals not only with respect to technology acquisition but also in connection with assimilation, adaptation and improvement. This extended package ultimately aimed at enhancing the national technological capability by training both workers and locals until the plant was running at satisfactory levels and to international standards. Economically speaking, this extended project was designed to make the foreign partner (the technology provider) committed to the long-term impact of their investment in terms of economic and technical achievements, which could be seen as a direct investment. Product-in-hand projects have succeeded in significantly reducing delays to project completion (i.e. attaining full production capacity) (Saad, 2001).

Saad has extended the traditional model by modelling a conceptual assessment model for the outcomes and ultimate success of TT projects. The ETT-PLC model suggests that project success can be classified into four categories:

- how effectively the project meets both budget and schedule
- customer impact or satisfaction
- business, or direct, success
- future potential

Saad presents an extended life cycle model (i.e. beyond the hand-over phase) to encourage the integration of these criteria into the decision-making processes. This can be seen as fundamental for TT projects. Also, he has argued that TT projects do not end with the hand-over phase; instead, TT projects are dynamic and shaped by interaction between various factors originating from many different sources. They are complex and risky in that they convey a great deal of uncertainty made up of technical, organisational, market, social, political and cultural factors. In this context, success is therefore not always guaranteed. The Algerian TT projects described in the case studies have essentially failed as a result of:

- Restricted availability of indigenous knowledge and information
- Poor preparation procedures prior to negotiations
- A lack of a proactive search for projects and partners
- Selection of projects and partners not being based on national realities
- Significant dependency on learning-by-doing and codified knowledge
- Ignoring the dynamic dimension of TT process and the consolidation stage

Consequently, this has led to a significant incompatibility between the imported technology and the recipient environment. This is why Saad's research challenges the traditional assessment approaches to project success and requires the need for an integrated approach that takes into consideration the key elements and stages of a TT project.

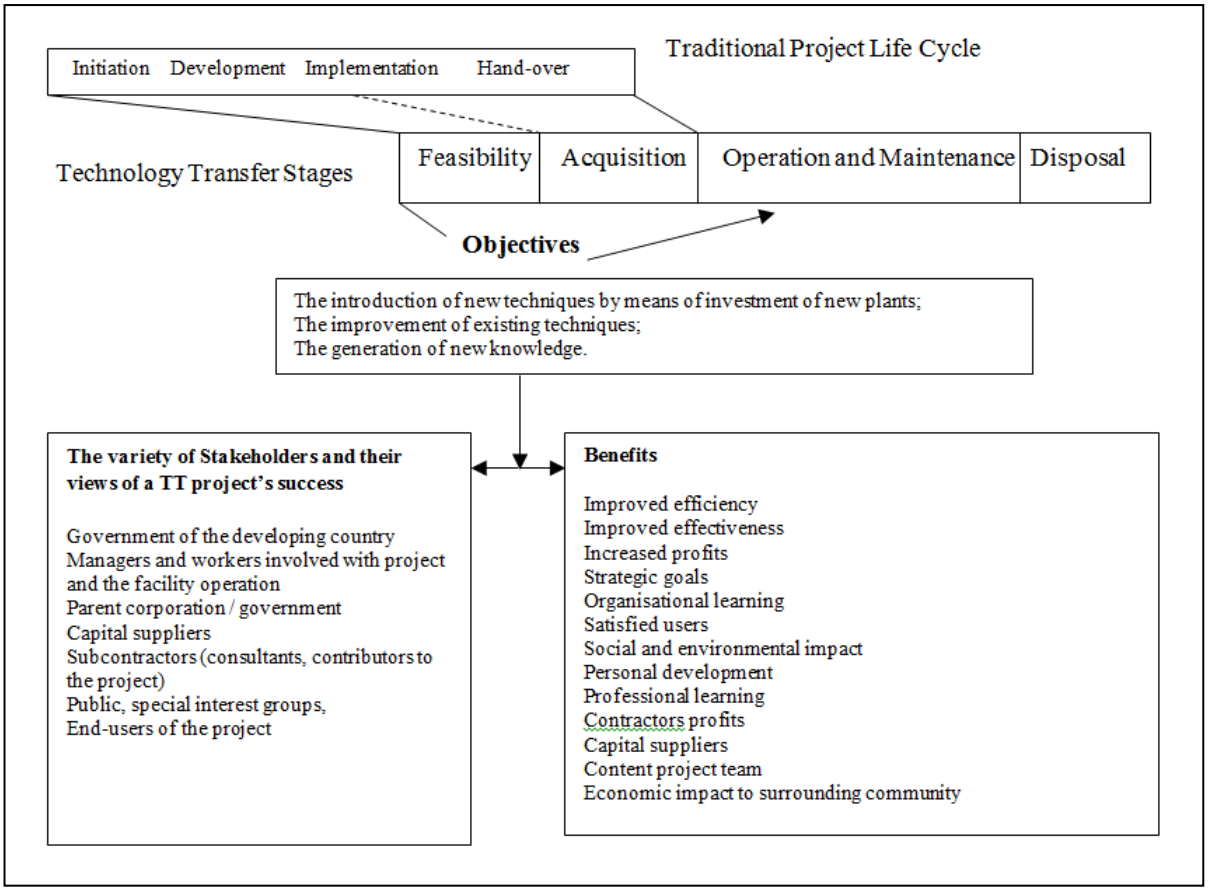


Figure 5.1: The extended TT project life for the assessment of TT project success (Saad, 2000)

5.3.2 Technology Acquisition Model (TA)

Simkoko (1992) presented a Technology Acquisition model (TA) for competence development using technology transfer packages. The model analyses the relationships between project management teams, technology acquisition strategies and project organisation. It also focuses on construction TT in developing countries by examining competence development through TT projects to determine the influential factors that impact the associated TT process. In investigating the model, Simkoko covered case studies of 12 international construction projects in developing countries in Africa, South America and Asia in 1987 and 1988. The selection criteria for the projects to be investigated were as follows:

- Local firm involvement
- Technology acquisition objectives that were explicitly or implicitly expressed by clients
- Projects completed recently or currently under construction

The objective of this research was to examine the impact of TT programmes and other internal and external environmental factors affecting the performance of construction projects. The data collection was separated into two phases:

- Phase 1: involved examination of project files and semi-structured interviews
- Phase 2: involved site visits and further interviews with all project participants

The technology acquisition process was identified as one of the main mechanisms for building up missing technological and managerial competence within firms in developing countries. The research also investigated the effect of organisational structure, the management team and construction technologies on the involvement of local firms. The TA model identifies seven sets of variables that describe the construction project delivery process (figure 5.2). The seven factors that constitute Simkoko's TA model are the following (Simkoko, 1992):

- *Project delivery system*: consists of organisation methods used and overall project execution.
- *Project management team*: Concerned with the degree of integration of local and foreign project managers. Influenced by organisational structures and acquisition programmes.
- *Transfer programmes*: Concerned with training costs and time, involvement of local contractors, employment of technical staff and management supervision.
- *Client characteristics*: Concerned with the special requirements of clients, personal characteristics of the client, financial status, degree of involvement in project decision-making and objectives.
- *Project characteristics*: Concerned with project size, complexity, schedule, cost, risks and uncertainties.
- *Design and construction technologies*: Concerned with construction methods, materials, equipment, resources, management techniques and past performance of construction technology.
- *Project performance*: Concerned with competence development of local firms, which was measured by the degree of involvement and impact on local employment.

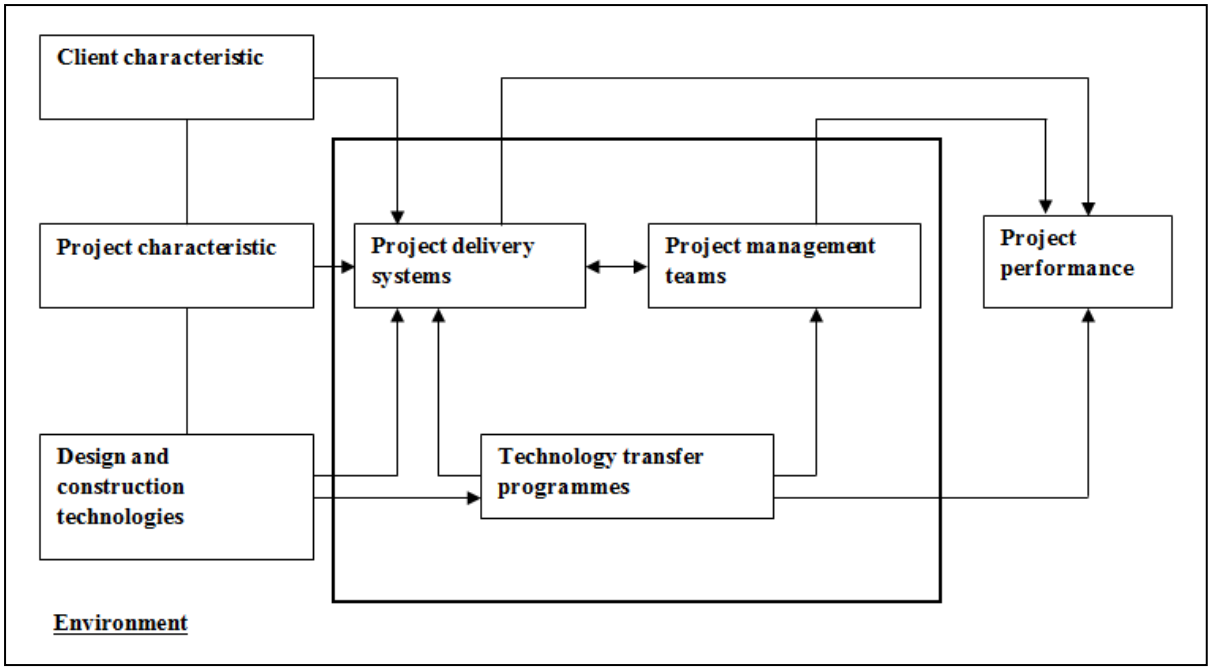


Figure 5.2: Simkoko research model: the relationships between the seven variables (Simkoko, 1992)

The relationships between the seven factors were analysed at both qualitative and statistical levels. The qualitative analysis suggested that there was a high involvement of local firms where management contracting was the dominant system of project delivery. Well-defined project objectives were set (i) by the intention of the clients to acquire specific construction and industrial engineering technologies, and also (ii) by contributing to a high level of involvement of local firms. In this context, the project performance was found to be a function of project management teams, technology acquisition programmes and the project's organisational structure. On the other hand, the statistical analysis of the relationships involved chi-squared tests and ranked correlation coefficients. The results obtained from the statistical analysis supported the qualitative results but also highlighted other relationships between factors such as the following (Simkoko, 1992):

- Effective technology acquisition is strongly affected by technology acquisition programmes.
- Participation of local professionals is essential for successful implementation of technology acquisition programmes.
- Project organisational structures that accommodate technology acquisition often have higher local involvement.

- Control and monitoring are necessary for effective technology acquisition.

This research model has given some insight into possible outcome factors to be used for the conceptual model for TT in international construction projects. Although this research was focused on competence development of local firms rather than the entire value added from the TT process, there are a broad range of competence development benefits described which could be applied to the overall value added through TT.

5.3.3 Incorporating Tacit Knowledge Model (ITK)

Li-Hua (2000) proposed a framework for effective knowledge transfer called the Incorporating Tacit Knowledge model (ITK). The ITK model focused on tacit knowledge transfer within international joint venture projects in the case study of China. In this model, Li-Hua had identified that *without knowledge transfer, TT does not take place, as knowledge is the key to controlling technology as a whole* (Li-Hua, 2000). The research was based on a structured survey undertaken in Jiangsu Province, Henan Province Xinjiang Autonomous Region in China. The survey examined a particular aspect of TT within Sino-foreign joint ventures in Henan. The findings suggested important implications for the relationship between TT and economy growth. TT is difficult to be achieved if the gap in economic development is too wide between transferor and transferee. Therefore, the research problem addressed in Li-Hua's study was:

> *What is the relationship between TT and economic growth? Are they positively or negatively correlated, or is the relationship between them more complicated? (Li-Hua, 2000)*

The data obtained from the study of construction activities in comparison with the economic indicators among Jiangsu, Henan and Xinjiang, suggested a national hierarchy of economic development. Jiangsu is at the higher level, Xinjiang at the lower level, and Henan in the middle position. Analysis and comparison of the data collected from the national line of economic development. In other words, there are features of knowledge transfer that appear to be associated with levels of economic development. To put it differently, this relationship between knowledge transfer and economic development is positively correlated. Figure 5.3 depicts a simplified view of the relationship between knowledge transfer and economic

growth. The arrow in the figure indicates that as the demand for knowledge transfer grows, the economy accordingly grows.

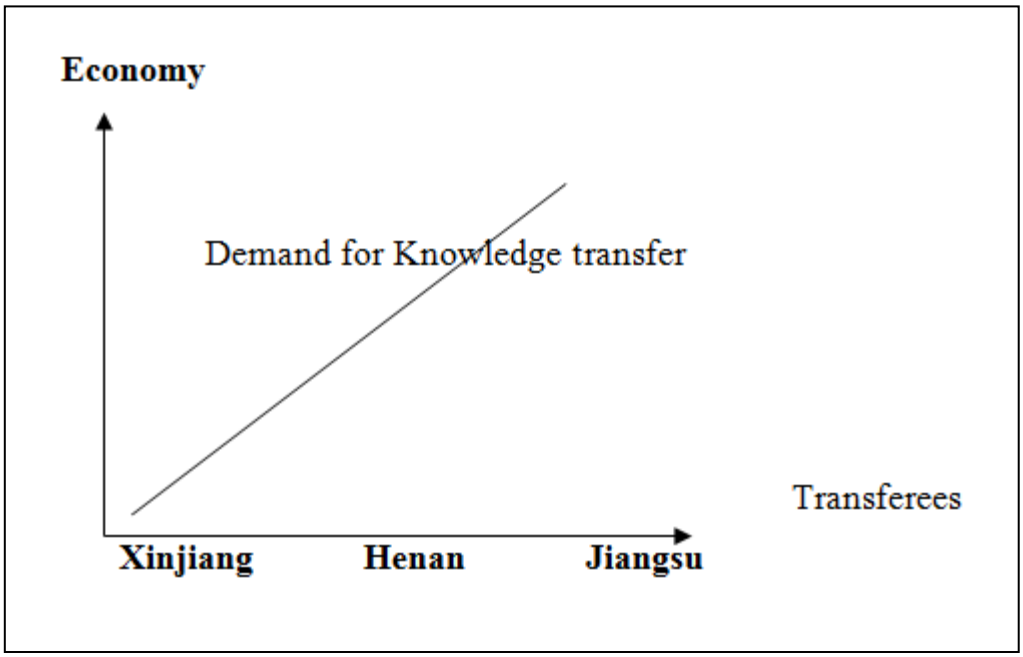


Figure 5.3: Relationship between knowledge transfer and economic growth (Li-Hua, 2000)

When comparing the three regions in terms of economy growth level, the findings show that there is more demand for tacit knowledge transfer in the well-developed region, while there is more demand for explicit knowledge transfer in the less developed region. In other words, tacit knowledge (soft knowledge) is preferred by residents of highly-developed economies, such as management know-how, while explicit knowledge (hard knowledge) is preferred by residents of less-developed economies, such as a specific technology for manufacturing a product. Thus, there is an X-shaped relationship between the need for tacit knowledge transfer and explicit knowledge transfer (figure 5.4).

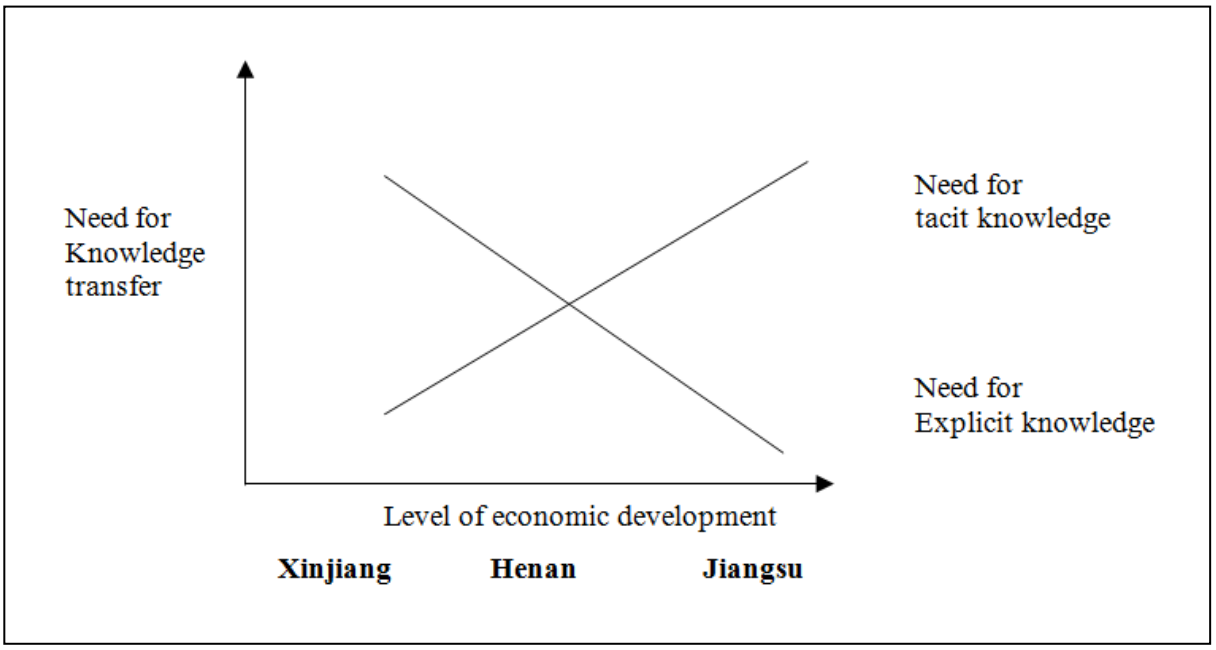


Figure 5.4: Relationship between tacit knowledge transfer and explicit knowledge transfer (Li-Hua, 2000)

Based on the above, it can be concluded that the desire to obtain more tacit knowledge increases while the desire to obtain more explicit knowledge decreases in line with levels of economic development. In other words, in a developing economy people are more eager to obtain explicit (hard) knowledge than for tacit (soft) knowledge.

The unit of analysis for the study was various *dyads* or management pairs with one foreign element and one local element, and whose roles require that they work together. There are in fact numerous forms of dyad, which are made up of foreign-foreign (F-F), foreign-local (F-L), and local-local (L-L) pairs, but for the immediate purposes of this research, only the foreign-local (F-L) dyads are of interest. Figure 5.5 represents the work patterns of dyadic interaction.

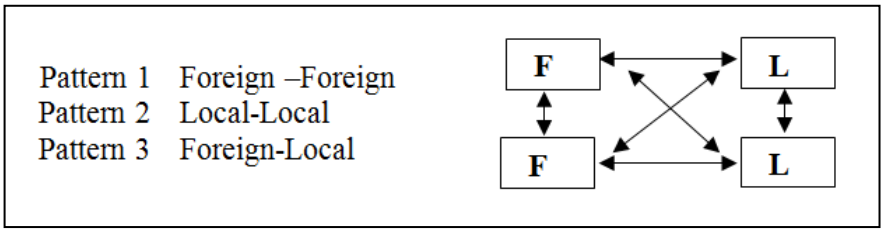


Figure 5.5: Work pattern of dyadic interaction (Li-Hua, 2000)

However, Li-Hua developed a framework for ensuring effective knowledge transfer, which was based on the literature review carried out by Mnaas (1990), Samli (1985) and Egbu (2000). Mnaas (1990) stated that technology consists of four inter-correlated elements:

- Technique
- Knowledge
- Organisation
- Product

However, Mnaas emphasised that knowledge is the core base behind technology and it is the key to controlling technology. Understanding explicit and tacit nature of delivering knowledge helps identifying the whole process of knowledge transfer.

In terms of how appropriate and effective TT is, Samli (1985) has modelled a pattern of TT with a consideration of six dimensions:

- Geography
- Culture
- Economy
- Business
- People
- Government

Addressing knowledge transfer issues in construction, Egbu (2000) developed a framework for managing knowledge, whereby he emphasised five dimensions, which were:

- People
- Content
- Culture
- Process
- Infrastructure and technology

Based on the range of research work available, it is possible to gain a wider understanding and significant insights towards building an effective and applicable model of knowledge transfer. In the model (figure 5.6) shown below, Li-Hua pointed out that this model combines both TT and knowledge transfer, where the importance of tacit knowledge transfer has been established and the obstacles to tacit knowledge transfer have been raised.

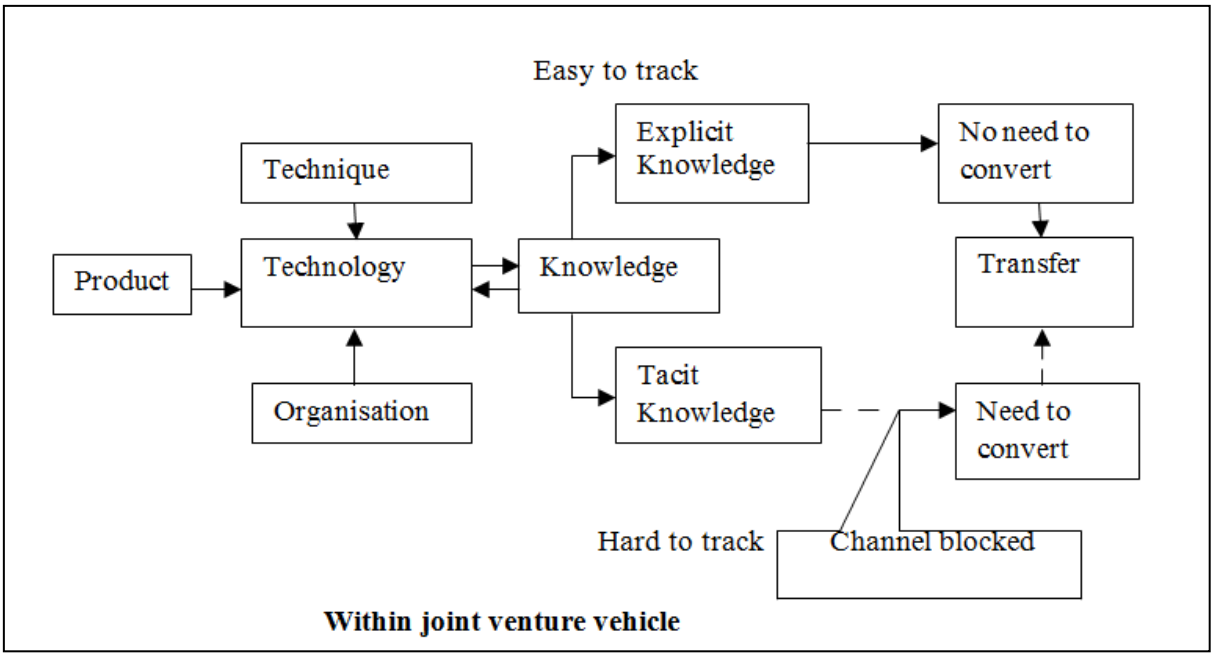


Figure 5.6: A model for efficient knowledge transfer (Li-Hua, 2000)

5.3.4 Value-Added Model (VA)

Waroonkun (2007) focused on modelling an effective and appropriate model for international TT within construction projects in Thailand. The new model is called the Value-Added model (VA). Although a number of existing TT models were developed for the business and manufacturing sectors, Waroonkun stated that he is not aware of any comprehensive TT model developed specifically for modelling TT in international construction projects. Waroonkun model was based on the literature review carried out by: Calantone *et al.* 1990; Lin and Berg 2001; Malik 2002; Simkoko 1992; and Wang *et al.* 2004, and used their models to propose a conceptual model that emphasised the results from a questionnaire survey of 126 industry professionals from Thailand.

Waroonkun states that over the last 20 years, numerous researchers have attempted to examine and/or model the international TT process (e.g. Calantone et al. 1990; Lin and Berg 2001; Malik 2002). A large proportion of these studies was predominately focused on the business and manufacturing sectors. Some of these empirical and qualitative studies resulted in the development of a framework or model for the international TT process.

Waroonkun produced a TT model for Thai construction projects and aimed to incorporate all of the relevant factors that influence the effectiveness of the TT process and the resulting in the VA model (figure 5.7).

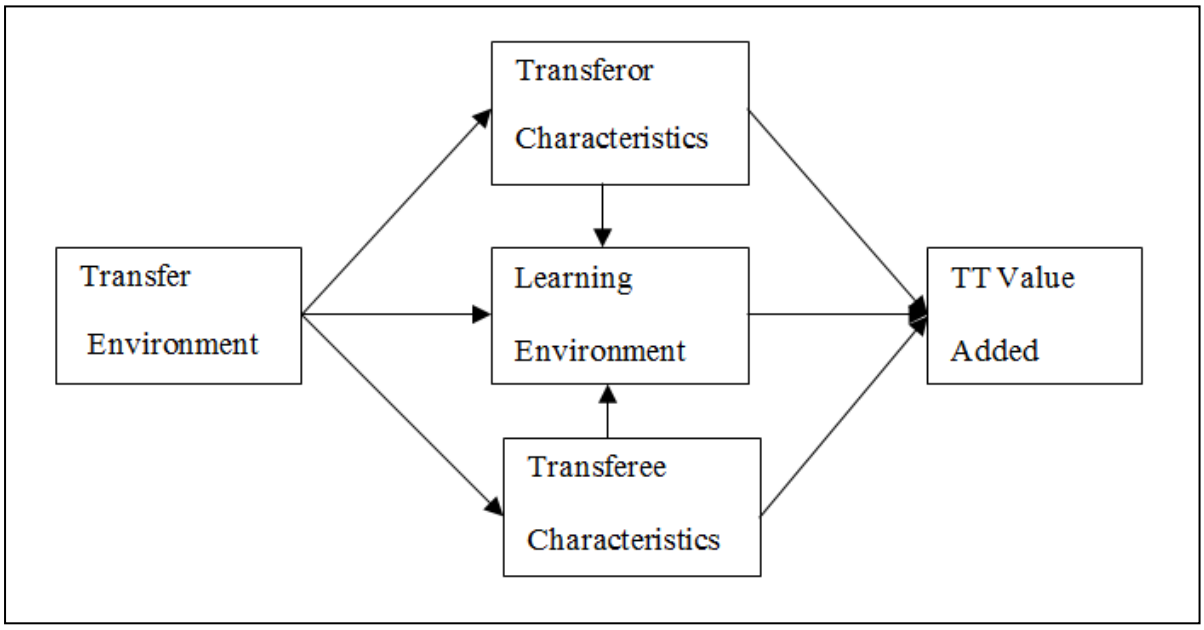


Figure 5.7: A model for international TT for construction projects in Thailand (Waroonkun, 2007)

The factors identified were classified as enabling factors and TT value-added factors. The classification process resulted in identifying five definable factors (constructs), namely, transfer environment, learning environment, transferee characteristics, transferor characteristics and TT value added.

Waroonkun has conceptualised this model based on some experiential understanding and therefore required each testing to confirm its appropriateness and validity. He has also described TT value-added factors in the above-mentioned enabling and outcome factors as follows:

- **Transfer environment:** this factor focuses at the overall picture of a country and its respective architecture and engineering construction (AEC) sector and the impact of project-related factors on the TT process. The transfer environment factor includes four other sub-factors, which are: (i) the complexity of construction technology utilised by the transferor; (ii) mode of transfer; (iii) government policy; and (iv) enforcement practices. The host government's policies, regulations and enforcement

practices can have a significant impact on enhancing the role of economic development and human resources in TT projects. It is worth mentioning that the construction technology used on the project is more advanced than the current working practices of the host workers but not too advanced that they will be unable to embrace it on future projects (Simkoko 1992).

- **Learning environment:** this factor focuses on the relationship between the transferor and transferee, the nature of communication, and the effectiveness of transfer programmes that are being implemented. It is essential to build a culture of mutual trust through effective communication between transferor and transferee (Black *et al.* 2000; Malik 2002).

- **Transferor and transferee characteristics:** The focus here is on the characteristics of the transferor and transferee that encourage the TT process (Kumaraswamy and Shresha 2002). Firstly, one essential element for achieving successful TT is the willingness of the transferor to transfer the appropriate technology and the readiness of the transferee adopting it (Ganesan and Kesley 2006; Malik 2002). Secondly, the level of international experience of both the transferor and transferee and the nature of this experience which can significantly impact the TT process (Lin and Berg 2001). Finally, the appropriateness of cultural traits that belong to both transferor and transferee (i.e. leadership style, personality, etc.) for working in a partnership should be determined prior to embarking into the TT process (Kumaraswamy and Shrestha 2002; Fisher and Ranasinghe 2001; Wang *et al.* 2004).

- **TT-induced value creation:** the performance of the above-mentioned factors can contribute to the degree of value added to the host AEC sector. There are three main areas (factors) that were derived from understanding international TT initiatives, which are: economic advancement; knowledge advancement; and project performance.

5.4 Evaluation of Related Work Models

This section will evaluate the four previously covered models of TT in light of a consideration of all the correspondent factors that affect the success of the TT process. This set of evaluations will be the basis for investigating the potential for proposing a new model that takes into account all the factors required to achieve a coherent process of transferring knowledge and technology to developing countries.

5.4.1 Evaluation of the Extended TT Project Life Cycle Model

This research studied the case of Algerian TT projects carried out between 1965 and 1990. This research is to some extent relevant to the case of Iraq, as Iraq and Algeria share common features in terms of geographical, political, economic, and social characteristics and, to some extent, they are at a similar scientific and cultural level of development. Moreover, the TT mechanism adopted by the former Iraqi government as similar as Algerian's one that the turnkey contracts were predominant in both Iraq's and Algerian's cases. Saad's research concentrated on the extended Project Life Cycle (PLC) of TT projects which is considered to be a kind of follow-up measurement. The (PLC) is a means to highlight the ultimate objective needs that will satisfy all stakeholders in the TT project. This emphasises the need for knowledge and technology to be transferred throughout the whole TT process. This research illustrates that the mechanism of TT is essential as it has an initial impact on the ultimate success of the project. This research stated that the product-in-hand method was clearly more successful than the turnkey mechanism. The reforms undertaken by the Algerian government in adopting the product-in-hand mechanism was better in terms of involving foreign experts to address the experience of failure. On the other hand, this reform was insufficient to cultivate an indigenous workforce as it remained reliant on foreign experts in the long term. Whereas, joint ventures allow the diasporas employing within technology transferor company organisation. As Saad argues, PLC is crucial in facilitating the TT process to achieve its ultimate objectives.

Owing to the characteristics possessed by Finn-Iraqis that would enable them to carry out their role effectively, may outweigh the Finnish experts, with regard to having knowledge of both Finnish and Arabic languages as well as the customs of both communities. Therefore, involving diasporas by Finnish partners would be beneficial as a force element due to their effective role in overcoming potential obstacles.

5.4.2 Evaluation of the Technology Acquisition Model

This research, which was undertaken from 1987-1988 and included an examination of previously completed construction projects, represents one of the few studies that address TT in the construction field. This research can be seen as a good example discussing TT programmes, as it occurred between a developed country such as Sweden and developing countries such as Tanzania, Kenya, Bangladesh, Colombia, Sri Lanka, Mozambique and India. Further, Sweden is very similar to Finland in terms of the construction technology that has been used by Finnish companies in Iraq. The research is more directed towards identifying the nature of involvement of local firms and personnel working on international construction technology. It illustrates the moderate factors (project delivery system, project management and TT programmes) that represent the model process. On the other hand, this research did not investigate the impact of diasporas, as this is considered one of the main moderate factors in facilitating the TT process.

5.4.3 Evaluation of the Tacit Knowledge Incorporating Model

The purpose of Li-Hua's model was to describe and investigate the issues related to the relationship between TT and economic growth. This model identified that without knowledge transfer, TT does not take place, since knowledge is the key to controlling technology as a whole. Hence, knowledge is crucial in the TT process. Li-Hua stated that TT is not attainable if there exists too large a gap in terms of economic development between transferor and transferee. Nonetheless, this model did not propose any solutions to overcome such a problem, although it did identify the channel that is blocked in tacit knowledge transfer and stated that this knowledge as criterion of the extent of acquisition.

5.4.4 Evaluation of the Value-Added Model

The purpose of Waroonkun's model was to focus on the value added to the TT project as a whole in order to evaluate its success. This argument is reasonable in the sense of measuring outcomes, as it is considered the outcome as the result of input variables and moderate variables interaction leading to the desired objects. Five variables were involved in Waroonkun's model, namely: transfer environment; learning environment; transferee

characteristics; transferor characteristics; and TT value added. These factors in turn have sub-factors, e.g. the transfer environment includes four sub-factors, which are: the complexity of construction technology utilised by the transferor; mode of transfer; government policy and enforcement practices. The last sub-factor (government policy and enforcement practices) is crucial in developing countries, particularly in Iraq, as it to some extent relates to the Iraqi environment. On the other hand, the learning environment is concerned with the nature of the relationship and communication between transferor and transferee, as well as the effectiveness of transfer programmes that are implemented. It is essential that a culture of mutual trust be established through effective communication between transferor and transferee (Black *et al.* 2000; Malik 2002; in Waroonkun 2007). However, this remains vague as Waroonkun did not provide a detailed explanation of how to enhance communication between transferor and transferee, which can be achieved by making use of the BBTs possessed by KTIs.

5.5 Potential for a New TT Model

The four TT models that were reviewed in the literature can be abstracted as in Table 5.2 below, showing their main target, context, key concept, factors, and assumptions. Scholars have discussed and identified factors e.g. language, culture as barriers that hinder TT process also the lack of training local staff. These factors have not been explicitly addressed through using efficient tools such BBTs that is used in this study. Further, the BBTs have been addressed as KTI that can enable this study develop DTT model (Dual Technology Transfer Model). However, all these elements that are highlighted and emphasised are eventually devoted to be factors in the success of the TT process as a whole. Thus, the effective and efficient factors of these models will be incorporated in the proposed model of this research. Furthermore, in addition to these factors, the proposed model adds other factors including KTIs possessing BBTs, long-term contractual agreements, R&D, and University-Industry (UI) collaboration.

Table 5.2: A comparison between the four TT Models presented showing their main target, context, concept, factors, and assumptions.

	Project Life CycleModel (Saad, 2002)	Technology Acquisition Model (Simkoko, 1992)	Tacit Knowledge Incorporating Model (Li-Hua, 2000)	Value-Added Model (Waroonkun,2007)
Target	The continuation of the project's performance by local staff.	Absorption of transferred knowledge to become rooted in the minds and skills of local staff.	Tacit knowledge transfer as an essential element for integrating TT as a whole.	Highlight to local staff the benefits of value added in order to undertake further projects independently with new technology.
Context/ Background	TT projects in Algeria for the period 1965-1990.	TT projects from Sweden into developing countries such as Tanzania and Kenya.	Highlighting view over the TT process within international joint ventures in China.	Highlighting TT initiatives within the construction sector and other industries in Thailand.
Key concept	Local staff performance in future projects based on product-in-hand.	Knowledge acquisition is the inductor for success of the TT process.	Relationship between TT and economic growth and how TT is channelled.	Value added by TT that can be reflected in local staff performance.
Factors	The six factors that make up this model are: technical; organisational; market; social; political; and cultural factors.	The seven factors that make up this model are: project delivery; project management; transfer programmes; client characteristics; project characteristics; design and construction technologies; and project performance factors.	This model, besides the four elements pointed out (i.e. technique, knowledge, organisation. and product) combines both TT and knowledge transfer, with importance being attached to tacit knowledge transfer.	The five factors are, namely: transfer environment; learning environment; transferee characteristics; transferor characteristics; and value-added factors.
Assumptions	Product-in hand was obviously successful than turnkey mechanism.	Involvement of local firms and personal working on international construction technology.	Tacit knowledge has to be transferred as technology cannot be transferred unless tacit knowledge (non-codifiable knowledge) is absorbed by local staff.	The final outcome is standard measure for local staff performance.

5.6 Summary

As a result of the literature study, four main TT models were identified and discussed in this chapter. The four models were: the extended TT PLC model; the technology acquisition model, the tacit knowledge incorporating model; and the value-added model. These models were carefully evaluated to emphasise their primary target, context, concepts, factors, and assumptions. The evaluation has led to an investigation of the potential for a new model that recognises the limitations of the existing models. Hence the new model is expected to provide a contribution regarding dual streaming technology transfer DTT by incorporating diasporas (Finn-Iraqis) in the TT model that can be used as a general international model for TT to developing countries.

The next chapter will present the proposal of this research, which is for a new TT model based on a set of chosen factors that will be capable of ensuring that knowledge and technology are successfully transferred smoothly and effectively to developing countries.

CHAPTER 6

DTT MODEL FOR CONSTRUCTION TECHNOLOGY TRANSFER

6.1 Introduction

The previous chapter has covered the related work of this research including the relevant models of TT in a variety of countries and transfer modes. These models have led to clarifying the need of a new model that can overcome the obstacles of transferring knowledge and technology smoothly and in an efficient manner. This chapter presents a proposed TT model in which the role of diasporas, that was concluded from the related work to be the shortcomings of the evaluated models, is an efficient means of enhancing the TT process between developed and developing countries. The proposed model is inspired by the best practice in the construction industry; however, it can be further applied in other industrial fields. The construction industry was chosen as a benchmark of adopting a new TT mechanism within international construction operation.

This chapter starts with presenting factors from the related models, which will be then utilised in the proposed model. Then, a general overview of the Dual Technology Transfer (DTT) model will be given, which will cover the diasporas dual role and dual TT mechanism. The overall architecture of the DTT model will be illustrated and discussed. Finally, a roadmap of validating the proposed DTT model will be demonstrated.

6.2 Utilising Factors from the Earlier Research

In chapter (5), the four TT models of the related work were presented and explained. It was noticed that each of the models discussed has its own strengths. These strengths are harmonious and interactive with each other. The four models have established the ground to develop a new conceptual model for international TT in construction projects. This section aims to abstract the factors of the four models that can be adopted in the proposed model of this research. The following will briefly summarise the objectives of each model subsequently.

- **Model-1: Extended TT Project Life Cycle (ETT-PLC) Model (Saad, 2000)** has illustrated the procurement and acquisition of the hardware, software and knowledge relevant to specific industrial. These elements considered as drivers to drive the process towards maintenance and sustainability for project performance by local staff independently. Factors that were highlighted from model-1 are namely: technical, organisational, market, social, political and cultural factors.
- **Model-2: Technology Acquisition (TA) Model (Simkoko, 1992)** is a technology acquisition model focused on the technology acquisition process and is identified as one of the main mechanisms for filling the missing technological and managerial competence of firms within developing countries. These missing competences cannot be settled into tools or devices due to their limited abilities, in contrast with human. Therefore, a human cannot be substituted all the time by developed smart devices due to properties that human possesses and abilities that enable human to be a processor within knowledge and technology acquisition. Factors that were highlighted from model-2 are namely: project delivery, project management, transfer programmes, client characteristics, project characteristics, design and construction technologies, and project performance factors.
- **Model-3: Incorporating Tacit Knowledge (ITK) Model (Li-Hua, 2000)** focused on tacit knowledge transfer within international joint venture projects and emphasised that without knowledge transfer being considered, no TT can occur since knowledge is the key to control technology. Tacit knowledge refers to hidden skills and expertise that to be transferred via human efforts since human has the ability of decoding puzzles and hieroglyphs of the tacit knowledge smoothly and effectively. Factors that were highlighted from model-3 are namely: technique, knowledge, organisation, and product factors.

- **Model-4: Value Added (VA) Model (Waroonkun, 2007)** focused on value-added giving a true reflection of the acquisition of required technology by local staff to perform in future projects independently. However, local staff has to be aware of absorbing value-added efficiently in order to be qualified enough to perform projects with new technologies adequately. Factors that were highlighted from model-4 are namely: transfer environment, learning environment, transferee characteristics, transferor characteristics, and value added factors.

As mentioned earlier, it can be concluded that the four models have emphasised knowledge and technology acquisition. Further, local staff performance and life cycle of projects have been considered as indicators to measure the success of the TT process. Table 6.1 summarises the key factors of the four models and highlights the factors that reflect the human and transfer mechanism drivers of these models. Figure 6.1 demonstrates the abstracted factors from the four models that will be embedded and utilised in the proposed model as will be explained later in this chapter.

Table 6.1: A summary of the related four models of TT process, with highlighting the factors that will be embedded and utilised in the proposed model of this research.

Model	Factor Acronyms	Factor Meaning
Model-1: Extended TT Project Life Cycle Model (ETT-PLC)	F1-1	Technical
	F1-2	Organisational
	F1-3	Market
	F1-4	Social
	F1-5	*Political*
	F1-6	*Cultural*
Model-2: Technology Acquisition Model (TA)	F2-1	project delivery
	F2-2	project management
	F2-3	*transfer programmes*
	F2-4	client characteristics
	F2-5	project characteristics
	F2-6	design and construction technologies
	F2-7	*project performance*
Model-3: Incorporating Tacit Knowledge Model (ITK)	F3-1	*Technique*
	F3-2	*Knowledge*

	F3-3	organisation
	F3-4	Product
Model-4: Value Added Model (VA)	F4-1	*transfer environment*
	F4-2	*learning environment*
	F4-3	transferee characteristics
	F4-4	transferor characteristics
	F4-5	value added

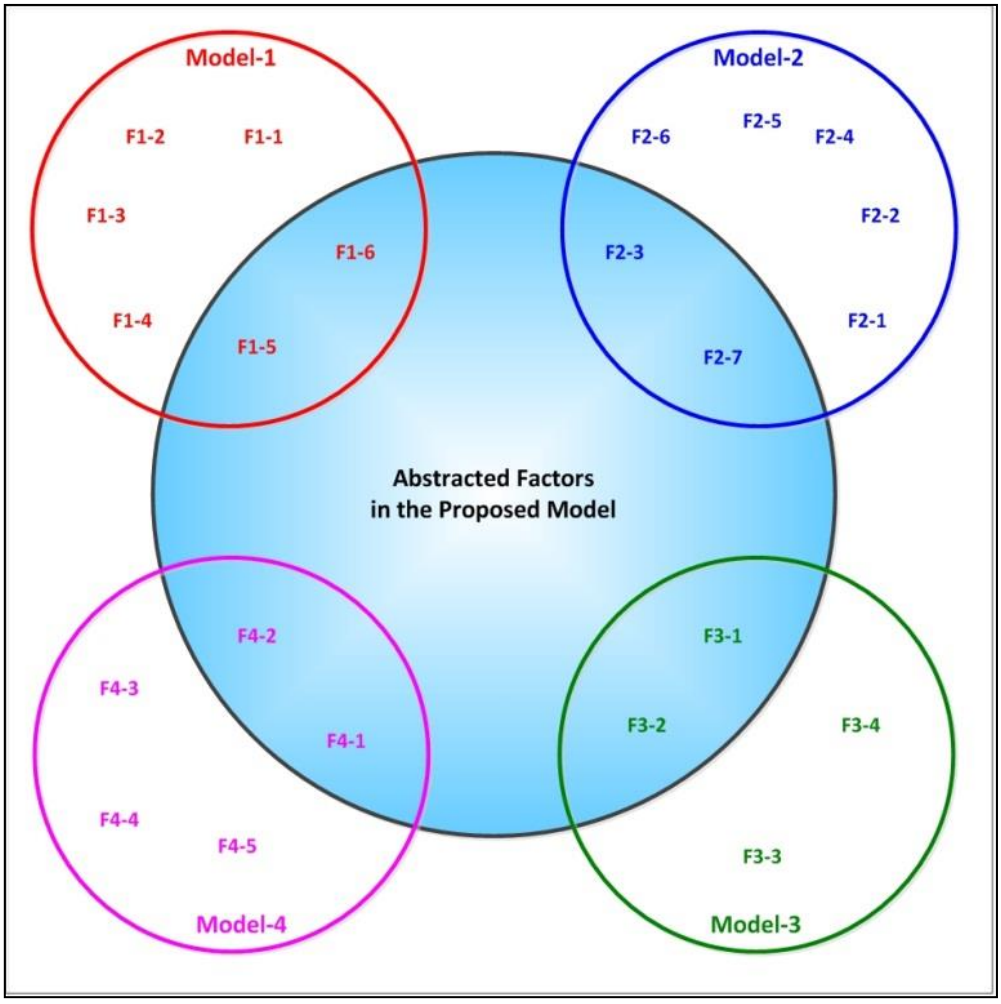


Figure 6.1: The abstracted factors from the four related models in chapter five in the proposed model.

To justify the chosen factors from table 6.1, these factors are abstracted and a justification of choice is given in table 6.2.

Table 6.2: An abstract of the selected factors from Table 6.1 and the justification of the choice of each factor.

#	Factor Acronyms	Factor Meaning	Justification of Choice
1	F1-5	*Political*	the political influence can positively or negatively affect the contractual agreement in developing countries
2	F1-6	*Cultural*	the literature has clearly indicated the impact of cultural issues on cross-border TT process
3	F2-3	*transfer programmes*	it includes the mechanism, strategy and technique of the transfer
4	F2-7	*project performance*	it is the ultimate indicator of whether the TT is successful or not
5	F3-1	*Technique*	the details of the transfer programme
6	F3-2	*Knowledge*	the core of TT process
7	F4-1	*transfer environment*	the umbrella that initiate, monitor and maintain the whole TT process
8	F4-2	*learning environment*	the engine of processing the TT and responsible for transferring knowledge and technology

6.3 Dual Technology Transfer (DTT) Model Overview

The core principle of this research implies reintroducing the philosophy of the TT mechanism to involve two ways of flow between the developed countries and developing countries. The focus of this research is on construction projects. Moreover, in order to guarantee successful transfer of technology, there should be a consistent approach to transfer knowledge beforehand. Therefore, the proposed model aims at providing a solution of transferring knowledge and technology that utilises the potential of reintroducing the human factor as a significant factor of amplifying the quality and capacity of the TT process. The human factor, or namely the *diasporas*, is the distinctive feature of this research, and it is integrated to perform two roles. The first role refers to the diasporas being the facilitators or mediators of knowledge and technology originated from the developed countries. In this case, the diasporas are referred to as Knowledge and Technology Integrators (KTI) and they utilise their unique skills of being bilingual, bicultural, and technical experts (BBT). In the second

role, the diasporas are being the source of knowledge and technology, in addition to utilising their skills of being BBTs.

Due to the *dual* nature of TT process and the *dual* flow of knowledge that are eventually received by the developing countries, this proposed concept will be referred to as the Dual Technology Transfer (DTT) model. It is the novel contribution of this research. The DTT model utilises the abstracted factors from the four related models and includes new conceptualised features to enhance the TT process. These features are namely (depicted in figure 6.2):

- **Diasporas** – as the main player of the proposed model.
- **Contractual Agreement (CA)** – involves all the contractual aspects that maintains and ensures the indication of TT process details within the contractual agreement.
- **Research & development (R&D) centres** – reflects the possible collaboration between local universities and industry with the foreign companies.
- **Cooperative Practice (CP)** – reflects the possible cooperation between foreign companies and domestic companies and local professionals that maintain long-term commercial and economic relationships between developed and developing countries.
- **Political Influence (PI)** – indicates all the political aspects that can positively or negatively interfere with the project performance in developing countries.

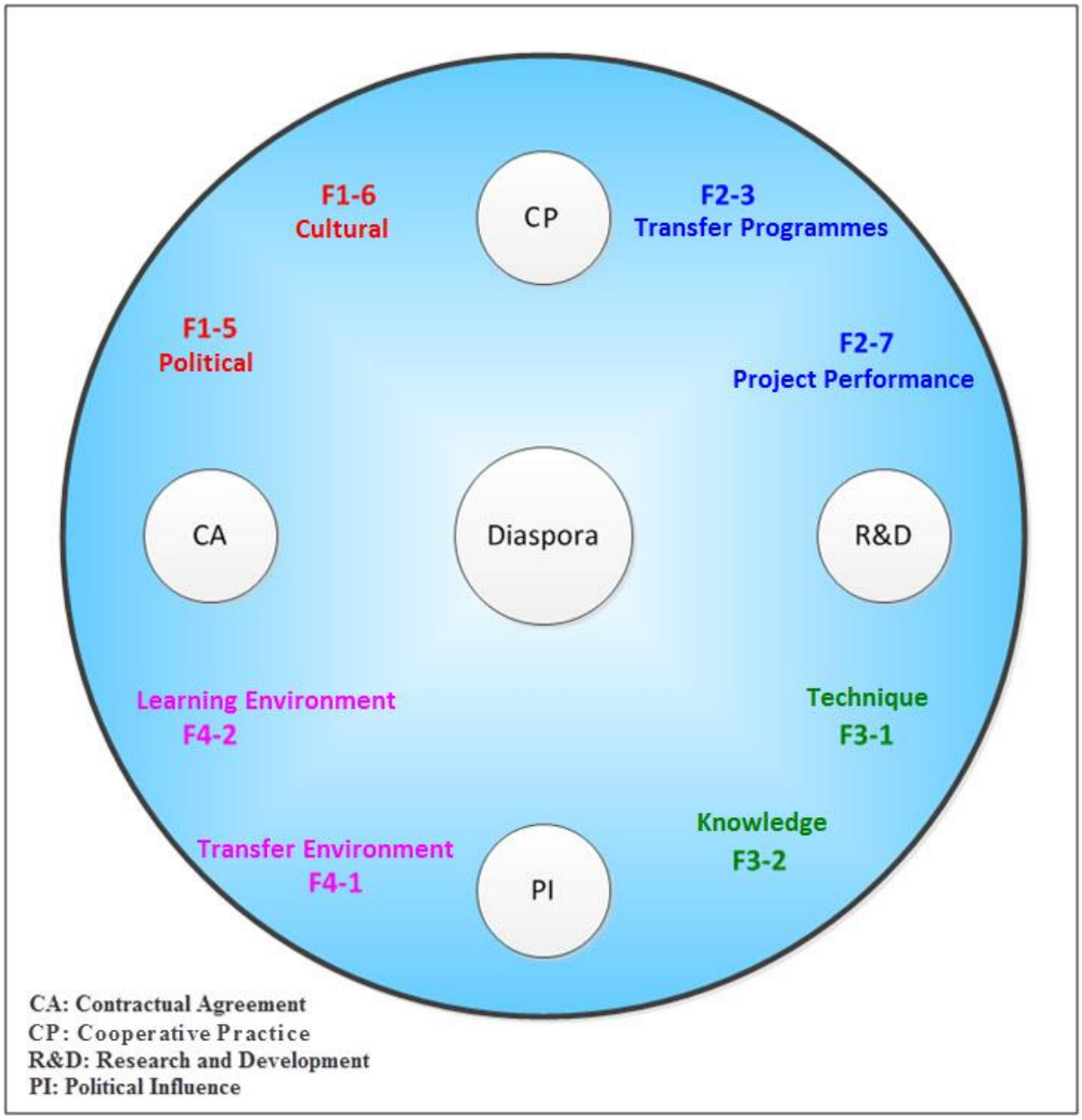


Figure 6.2: Conceptual Overview of the proposed DTT model.

The DTT model consists of two conceptualised wings: the Diasporas Dual Role and the Dual Technology Transfer Mode. These two wings of the DTT model will be considerably covered in the next two subsections.

6.3.1 Diasporas vs KTIs

As discussed in chapter (5), the main factors of the four models can be categorised into transfer environment and learning environment factors. Transfer environment factors involve: project characteristic, economic development and Gross Domestic Product (GDP) and government policy and enforcement practices. While learning environment factors involve: transferor and transferee characteristic, contractual agreement, knowledge type and transfer mode. These models have not dealt with human factors in details e.g. incorporating tacit knowledge factor has been seen as an important factor to be incorporated within TT process without considering the mechanisms that produce motivation to make tacit knowledge as a decoded, vital and active factor within TT process. Factors that produce the vitality to other ones can be termed as *integrator* factors. Therefore, these factors of the four models cannot be effective unless the so-called integrator factors are included. These integrator factors in this study are named the **Knowledge and Technology Integrators (KTIs)**, which refers to the *diasporas* (e.g. *Iraqis living in Finland) who are employed as a link between transferor and transferee.* KTIs are diasporas who possess unique characteristics; particularly, bilingual, bicultural and technical expertise, which enable them to be integrated in TT process effectively (see figure 6.3).

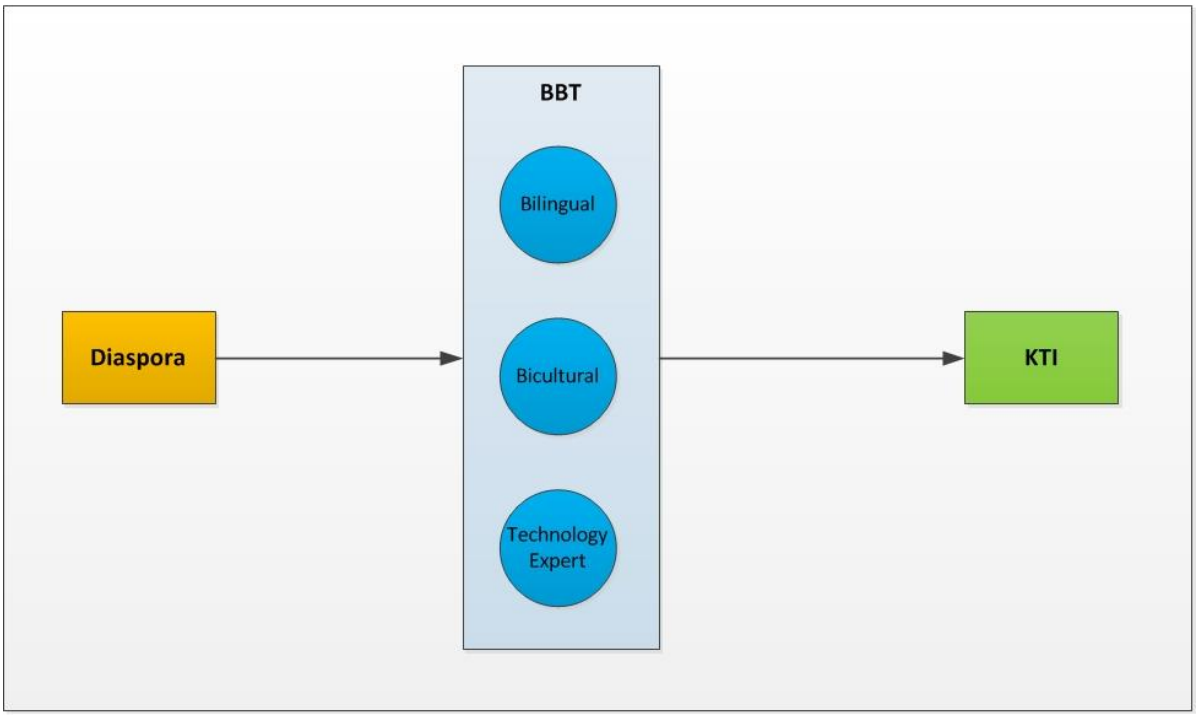


Figure 6.3: KTIs are diasporas who possess characteristics such as bilingual, bicultural and technology expertise.

6.3.2 The Dual Technology Transfer Mechanism

The TT process can be accomplished by considering the transfer of the required knowledge that ensures the awareness and effectiveness of the technology implementation. However, the conventional approaches of TT do not emphasis on the importance of accompanying the knowledge with the technology when implementing construction projects in developing countries due to several reasons. These reasons mainly arise since the governments in developing countries do not usually realise the effective mechanism of TT that ensures transferring both knowledge and technology simultaneously. A good example of such conflict of understanding occurred in Iraq in 1970s -1980s when Finnish companies implemented construction project with the Iraqi government. In these projects, there was no knowledge transfer due to the political influence that prohibited local people involvement within the implemented projects. Such mechanism of TT can be seen as a horizontal transfer, which is normally applied among developed countries where knowledge exists in both sides. However, when it is applied from developed countries to developing countries, it would lack knowledge transfer, such as the case of the Finnish companies and Iraq. Figure 6.4 depicts the horizontal TT between developed and developing countries.

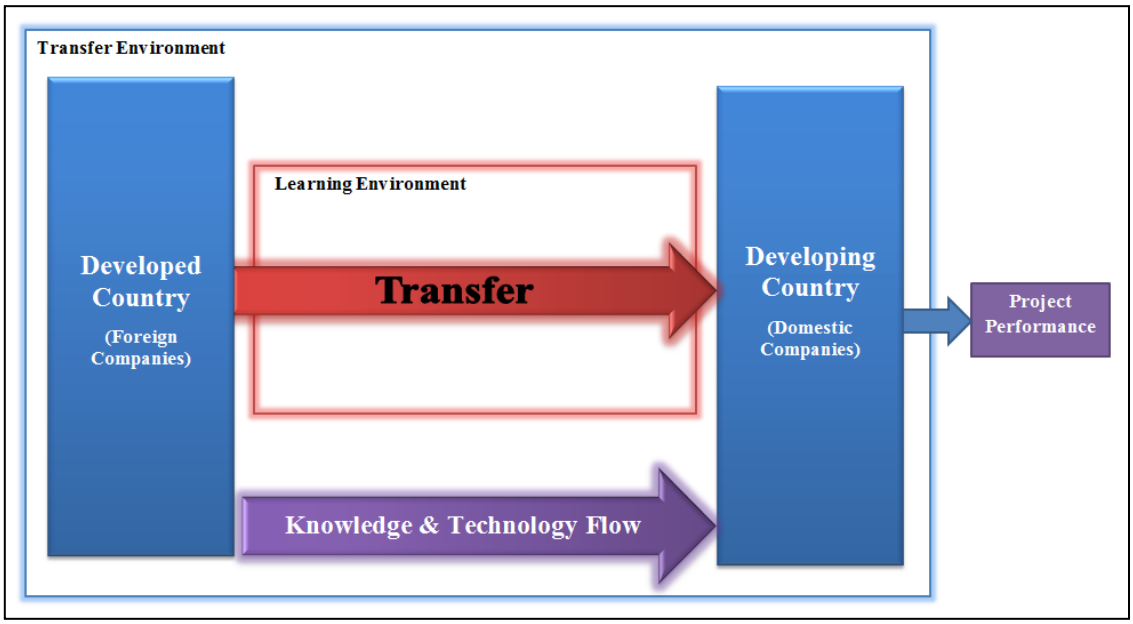


Figure 6.4: Horizontal Technology Transfer model for the construction projects that was applied between the Finland and Iraq in 1970s-1980s.

This conflict of understanding can be resolved by introducing the vertical transfer model as an alternative solution. The vertical transfer model ensures that the developing countries involve the necessary amendments in the contractual agreement that guarantee transferring

the knowledge along with technology. However, the conventional vertical transfer model faces cultural and language barriers that hinder the TT process. To overcome these obstacles, this research proposes involving the diasporas who can play a crucial role in resolving the cultural/language barriers through redefining the TT mechanism by adopting four factors (figure 6.5), including Contractual Agreement (CA), Research & development (R&D) centres, Cooperative Practice (CP), and Political Influence (PI). The diasporas will have two main roles in the new proposed model:

- **Mediators of knowledge/technology:** since they are bicultural and bilingual, they are considered as mediators of knowledge/technology when transferred from the developed to developing countries.
- **Source of knowledge/technology:** since they have technology expertise, they act on behalf of the developed countries to transfer knowledge/technology.

Figure 6.5: The diasporas (KTI) as the core of the TT process.

6.3.3 DTT Model Architecture

The proposed DTT architecture adopts the vertical TT model which will be enhanced by involving the diasporas. The DTT model aims at providing an effective mechanism of TT between developed and developing countries, most importantly in construction projects. The governments in the developing countries utilise the contractual agreement and the political influence to involve conditions of transferring knowledge side by side with technology. In this case, the source of knowledge/technology is the foreign companies of the developed countries. This is referred to as Transfer-I as shown in figure 6.6. In Transfer-I, the diasporas will play a major role of facilitating the transfer process by acting as mediators due to their bicultural and bilingual skills.

On the other hand, the diasporas can be the source of knowledge/technology due to their technology expertise. In this scenario, the diasporas are considered as technically qualified foreign staff in terms of experience and expertise but with local cultural and language skills of both transferor and transferee. This stream of transfer process is referred to as Transfer-II (figure 6.6).

The learning environment in the proposed DTT model will provide dual transfer mode (Transfer-I & Transfer-II), in which diasporas are the core factor of knowledge/technology transfer.

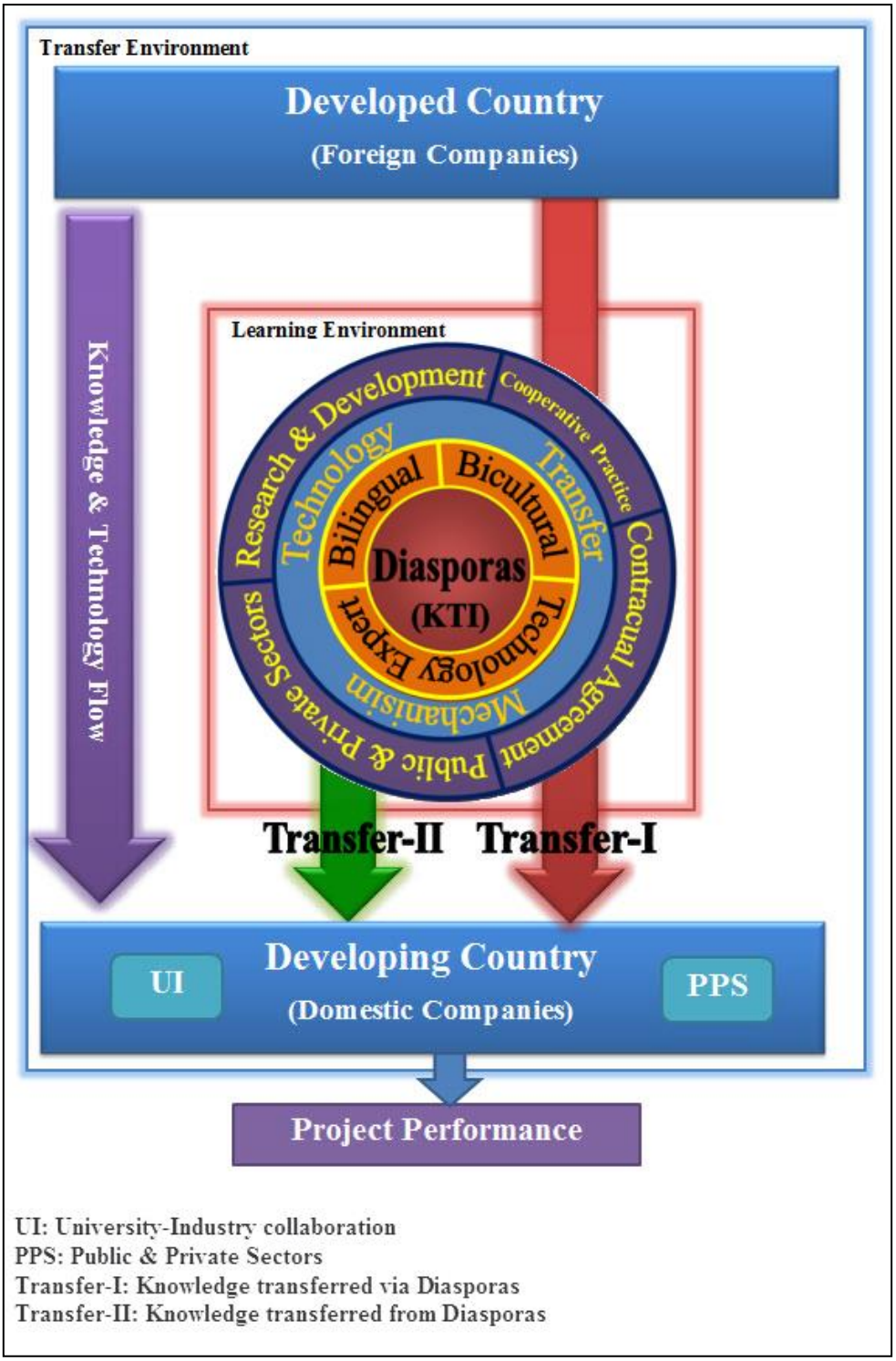


Figure 6.6: The DTT Model Architecture showing the dual model of knowledge & technology transfer between developed and developing countries.

Finally, the factors of the proposed DTT model which are illustrated in figure 6.6 can be compared with the abstracted factors of the four TT models that were summarised in table 6.2 in order to evaluate whether the abstracted factors from the literature are integrated in the new DTT model. Table 6.3 shows the comparison between the two sets of factors.

Table 6.3: A comparison between the factors abstracted from the four TT models of the literature (table 6.2) and the factors of the proposed DTT model illustrated in figure 6.6

#	Factor Acronyms	Factor Meaning	DTT Model Factors	Match?
1	F1-5	*Political*	Political Influence	☑
2	F1-6	*Cultural*	Bicultural & Bilingual	☑
3	F2-3	*Transfer Programmes*	Transfer-I & Transfer-II	☑
4	F2-7	*Project Performance*	Project Performance	☑
5	F3-1	*Technique*	The duality of transfer of knowledge and technology	☑
6	F3-2	*Knowledge*	Knowledge Flow	☑
7	F4-1	*Transfer Environment*	Transfer Environment	☑
8	F4-2	*Learning Environment*	Learning Environment	☑

6.4 Roadmap for DTT Model Validation

The proposed DTT model stands on emphasising the role of diasporas and the importance of the dual transfer mode in the TT process between developed and developing countries. In order to examine the validity of the proposed DTT model, two different case study approaches have been adopted for studying the research hypotheses. The chosen approaches cover the construction projects implemented by the Finnish companies in Iraq during 1970s and 1980s. The first case study approach, which is called Single Case Study, covers the Baghdad Congress Palace construction project (1978-1982). In this study qualitative data collection was done through face-to-face interviews that were conducted with professionals who were involved in the case project. The second case study approach, which is known as a multi-case study, covers other construction projects that were implemented by Finnish companies in Iraq (1970s-1980s), In this study quantitative data collection was done through

questionnaires that were sent electronically to the professionals who were involved in these projects. The two case study approaches with their results are covered in detail in chapter 7.

The selected two case study approaches comply with the proposed tri-pillar research method (chapter 2), which introduced the utilisation of three research pillars including literature review (covered in chapters 3 & 4), single case study (qualitative data), and multi-case study (quantitative data).

6.5 Summary

This chapter presented a new model that was developed as a part of this research. The model is called the Dual Technology Transfer (DTT) model. The 'Dual' term was chosen here to refer to the duality of roles the diaspora can play in TT process when either represent the integrators between transferor and transferee or when represent the source of knowledge/technology to be transferred. The chapter started by highlighting carefully selected factors from the related models covered in the previous chapter. The chosen factors are Political, Cultural, Transfer Programmes, Project Performance, Technique, Knowledge, Transfer Environment, and Learning Environment. The reason of choosing these factors and not the others is because of its relevance to the objective of this research which is the proposing a new international TT mechanism regardless the custom requirements of the analysed models. Moreover, it was crucial to generalise the DTT model and avoid any localisation related to the context of knowledge/technology to be transferred or the client/project characteristics. These factors are included in the DTT model together with novel aspects of integrating the role of the diasporas in the TT process and emphasising the importance of the dual TT mechanism. The overall architecture of the DTT model was also explained. Finally, a roadmap of validating the proposed model was discussed, showing the need for two case study approaches that gather qualitative and quantitative data and analysing and evaluating these data to examine the validity of the model.

The next chapter presents the conducted two case study approaches (Single and Multi) together with the gathered data from the face-to-face interviews and the electronic questionnaires.

CHAPTER 7

TESTING THE DTT MODEL AND RESEARCH HYPOTHESES

7.1 Introduction

The purpose of this chapter is to introduce the reader to the approach that is used to test the DTT model and research hypotheses. The approach shows the use of literature review of fresh case studies and the insights based on the author's own experience, and to show the design of the single case study (SC) and multi-case study (MC) that were adopted in order to test the DTT model and the research hypotheses. Further, to let the reader be aware of specific background research objectives especially focusing on TT components e.g. local staff and diasporas involvement, cross-cultural and language barriers, political impact and contractual agreement.

This chapter starts by giving an overview of two recent case studies and the author's own experience as diaspora in Iraq. Then, the overview of the single case study includes introducing Baghdad Congress Palace project and the interviews conducted for the SC. Then, the key factors of these interviews will be identified. This will be followed by presenting the gathered data from the SC, which is categorised into four types including (i) involvement of local staff and diasporas, (ii) human bicultural and bilingual factors, (iii) political intervention, and (iv) contractual agreement. Further, a discussion on the SC findings will be demonstrated. After that, the multi-case study will be presented. This will be followed by an overview of the gathered data in MC, which includes an evaluation of international TT in both the traditional approach and the proposed DTT model approach. Finally, the findings of the MC will be discussed.

7.2 DTT model against findings from literature and insights based on author's experiences

As presented earlier in explaining the research approach (section 2.2), in order to ensure the reliability of the research outcome, a tri-pillar approach is adopted to test the research hypotheses, which consists of (i) a literature review (ii) a single case study (Baghdad Congress Palace), and (iii) a multi-case (questionnaire survey). The literature review is divided into two phases. The first phase was covered in chapters three, four and five respectively. The outcome of this phase was to identify the common factors that were utilised to propose the DTT model. The second phase of the literature review will be covered in this chapter. The second phase will cover fresh TT case studies that verify the validity of the chosen characteristics of the DTT model. This phase was included in this chapter, along with the other two pillars; the SC and MC case studies, in order to consolidate the tri-pillar approach of this research.

The next subsections will review two studies made by researchers focusing on identifying the influence factors on TT in Asia (Lai & Chao, 2006) and Africa (Janssen, 2010), followed by a third case study covers the author's own experience with TT in Iraq (2003-2005).

7.2.1 TT Case Study in Asia (Lai and Chao, 2006)

Lai and Chao (2006) have investigated the importance of considering cultural and language challenges in TT international operations. The examined case study was to analyse the impact of cross-cultural issues on managing TT from the United States to the Greater China Region (Taiwan and PR China). The case study focuses on the phenomenon of the increasing interest of multinational corporations in the US seeking product outsourcing in the Asia region, particularly in the Greater China Region due to the rapid growing of global economy. The authors have reviewed the available literature that targets this phenomenon and have concluded that there are many methods of TT that vary widely depending on certain influence factors, such as domestic demand, scale of production, trade-offs, machine capabilities, in addition to costs that influence the type of industry and management, complexity and expansion of the TT process. The authors have then summarised these factors as in figure 7.1 (Lai & Chao, 2006). It can be clearly indicated from the diagram that the human-related factors such as cultural, personal and knowledge specifications, have direct influence on the TT process.

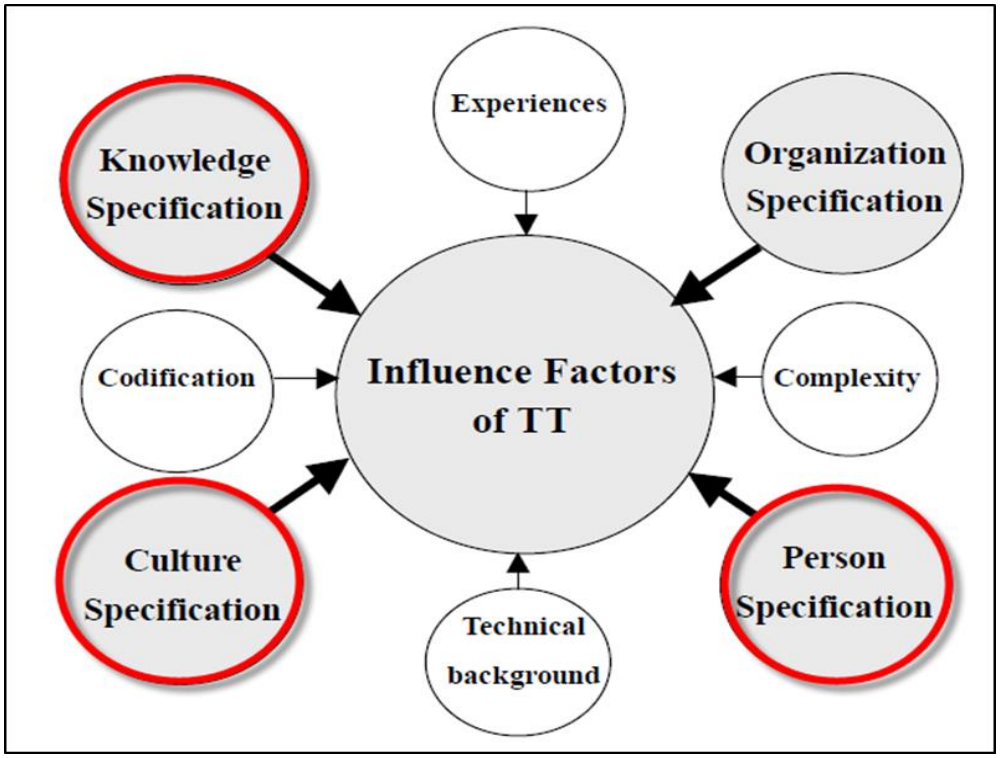


Figure 7.1: Influence factors on TT, emphasising culture, personal, and knowledge (Lai & Chao, 2006)

According to the authors, in order to operate effectively and successfully in cross-cultural projects, there is a crucial need for 'intercultural professionals' to understand divergent cultural attitudes, beliefs and behaviours. This assumption is made since misunderstanding resulted from miscommunication, and inadequate communication often leads to working on the wrong tasks, resulting in schedule delays, allocating unwanted resources, wasteful efforts and reduced synergy, which eventually jeopardising the project performance and even the cooperation between the two partners. Consequently, the authors have proposed a model for successful project management in international cross-cultural TT. The proposed model aims at establishing cooperative practice between the transferring company in one country and the receiving company in another country. This can be accomplished by establishing a small subsidiary collocated inside the transferring company premises, formed by a team from the receiving company with bicultural and bilingual skills. The primary roles of the diasporas team is to smooth the daily communication between transferring and receiving companies, provide site assistance to customer, and interpret contractual ambiguities in every step in the course of TT. This team would serve as the 'virtual bridge' between the two contracted parties (Lai & Chao, 2006). The authors have illustrated their proposed model as shown in figure 7.2.

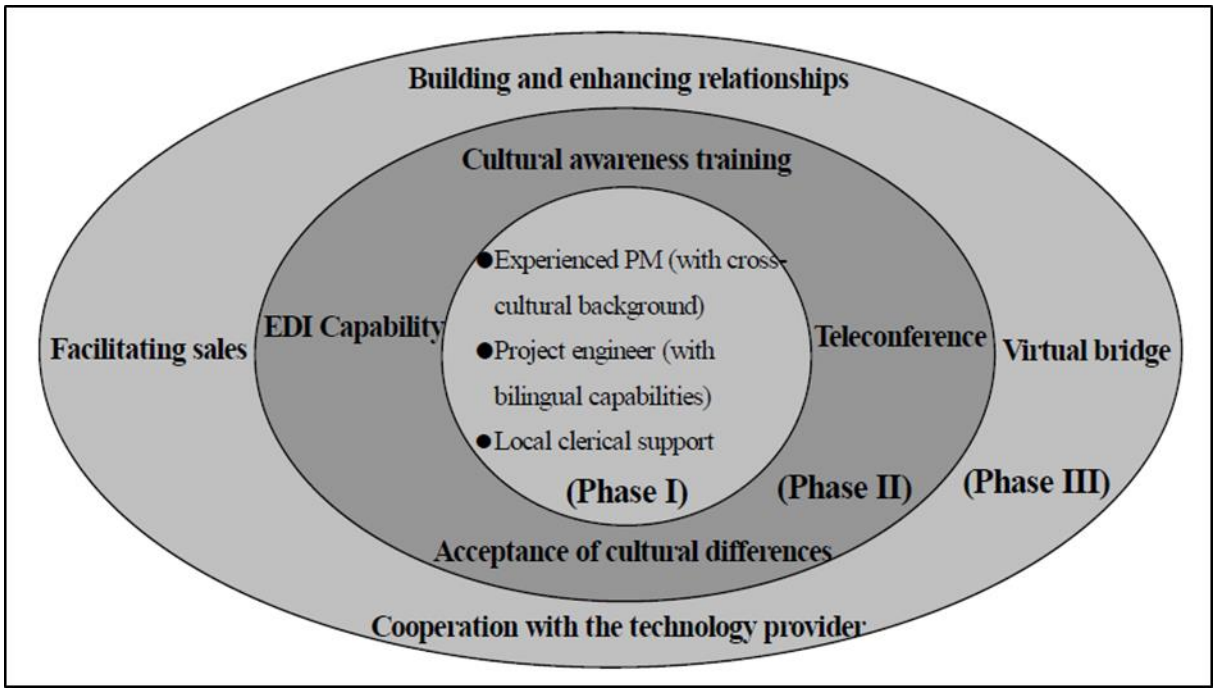


Figure 7.2: A model for successful subsidiary team integration for TT international operations between US and Greater China Region (Lai & Chao, 2006)

To test the validity of the proposed model, the authors (Lai & Chao) have used two techniques; qualitative and quantitative research methods. The qualitative research was accomplished by interviewing (face-to-face and by phone) six senior executives who have been actively involved in U.S. to China business management over -at least- the past three years and a minimum presence in Chine of ten years. Concurrently with the interviews, the authors have applied quantitative research by conducting surveys. 150 survey letters of questionnaire questions were distributed to U.S. headquarters of American firms running subsidiaries, sales offices or JVs in China. A total of 31 responses were received in a return rate of 20.78%. The collected data from both research methods were statistically analysed by applying correlation analysis in order to test the hypotheses and verify the validity and reliability of the survey data (Lai & Chao, 2006).

Interestingly, the outcomes of the results analysis have shown that American firms benefit from assigning Chinese diasporas to head up their subsidiaries in China. This includes communicating effectively with the Chinese, understanding the sensitivity to major political issues in China. For instance, US executives emphasised that it is important for Americans working in China to avoid participating in discussions involving political issues. Also, they emphasised the criticality of personal ‘guanxi’ (relationship) with officials in the Chinese

governments (Lai & Chao, 2006). Furthermore, the results have shown that employment of expatriates to manage TT project would substantially increase the possibility of project success. A final conclusion about this case study is that owning to the time and efforts needed to build and sustain business relationships between dissimilar cultures, diasporas who possess culture awareness and language skills can be the key to achieving success TT.

7.2.2 TT Case Study in Africa (Janssen, 2010)

The second study to be reviewed is the experience of the Dutch company; Soil & More International B.V. with transfer technology to five African countries (Janssen, 2010). Soil & More, founded in 2007, has developed an advanced Controlled Microbial Composting (CMC) technology that produces high quality compost in less than half the time needed in other composting methods and helps to efficiently avoid methane emissions. It is also the first company in the world that developed a technology that generates verified carbon credits from organic composting. In its efforts to commercialise its innovation through licensing the technology to international partners, by 2010, Soil & More successfully signed licensing agreements in Brazil, India, Egypt, Mexico and South-Africa. Moreover, to further enable the company to generate revenue from its innovation and expand its network quickly without having direct investments in potential parties in five African countries, it was crucial to investigate the best approach to transfer its new technology efficiently and effectively (Janssen, 2010).

Janssen (2010) of the University of Twente in the Netherlands, and in partnership with Soil & More International B.V., has dedicated his study to investigate the influencing factors on commercialising TT process of this innovation to the five targeted African countries (Botswana, Ethiopia, Mauritius, Mozambique and Tanzania). Janssen reviewed four methods that can be used to improve TT, which are communication, franchise handbook, training and creating cultural awareness. According to Janssen, it was observed that creating cultural awareness is the method that should be considered first in TT process since it improves the effectiveness of the other three methods. Therefore, Janssen started the literature with reviewing the impact of culture and the perceived cultural distance on both technology transfer and knowledge transfer, as well as its impact on implementing TT through training. The research included the cultural distance factors that directly or indirectly affect the transfer of technology between the sender and receiver, which include five dimensions (Janssen, 2010):

- Individualism/Collectivism
- Power distance
- Uncertainty avoidance
- Masculinity/Femininity
- Long- vs. Short-term orientation

Accordingly, Janssen has proposed a conceptual illustration emphasises that when a company tends to commercialise its technology, the technology to be transferred would be obstructed by a cultural barrier. Figure 7.3 illustrates a conceptual model of TT in a cross-border context.

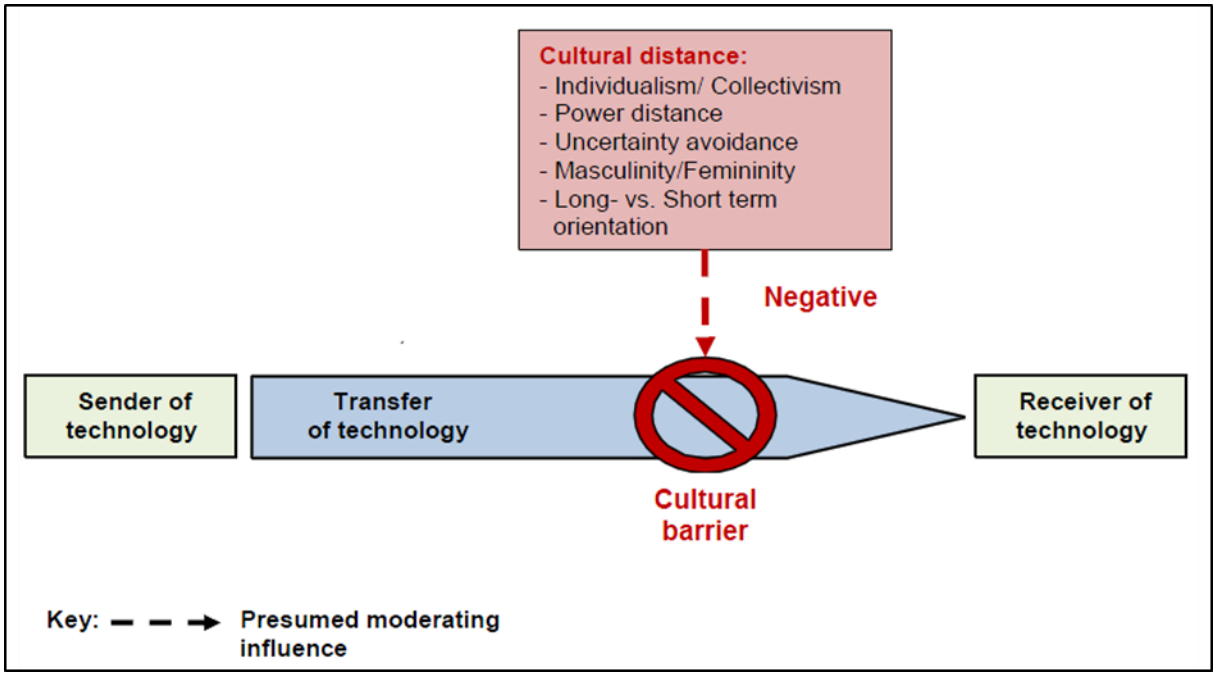


Figure 7.3: Janssen's model that addresses the cultural distance barrier in technology transfer in a cross-border context (Janssen, 2010)

To validate these findings using qualitative research method, Janssen has conducted two sets of interviews. The first set of interviews targeted seven employees of different functional levels in Soil & More. To support the findings of the first set, the author has also conducted a second set of interviews with six members of an independent control group called the NL EVD International (formally known as the EVD or in Dutch 'Economische Voorlichtingsdienst'). The NL EVD International is known as the Agency for International Business and Cooperation, which provides country-based business information for public- and private-sector organisation in the Netherlands. The outcome of analysing the results of

the two sets of surveys have shown that in order to lower the cultural barrier in TT, it is crucial to create cultural awareness, which can be implemented by providing sufficient training to the company staff who are to work abroad in countries of significant cultural distance. The findings and results outcomes are illustrated in figure 7.4.

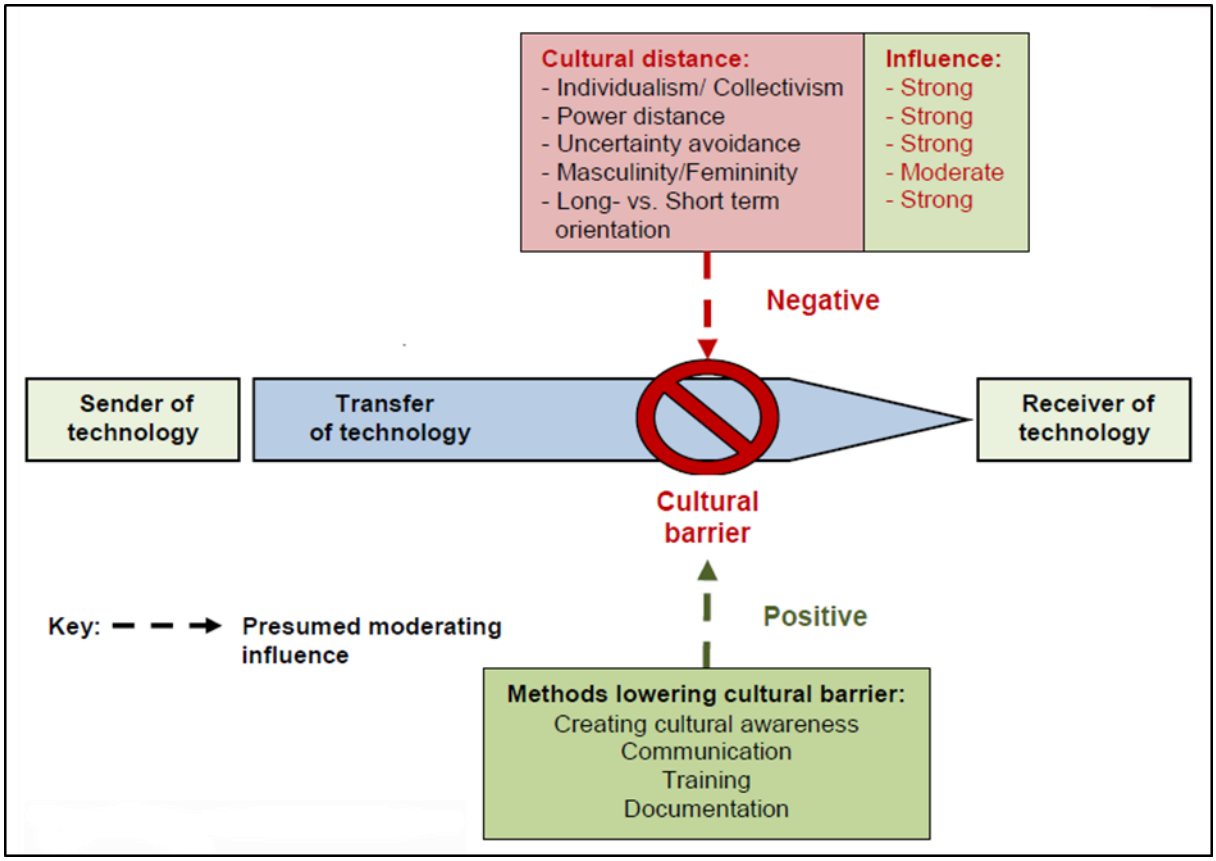


Figure 7.4: Janssen's model of technology transfer to overcome the cultural distance barrier by creating cultural awareness via communication, training and documentation (Janssen, 2010)

Janssen has also recommended creating culturally responsive joint-venture alliances to reduce cultural barriers. It can be also noted that the role of BBTs can ease cultural issues in the TT process when considering the relationship between the transferor and transferee.

7.2.3 Author's Own Experience with TT in Iraq (2003-2005)

In addition to the two case studies mentioned earlier (China and Africa), final supporting evidence represented by the experience of the author of this research when he had the opportunity to act as a diaspora by himself for a Finnish company in Iraq between the period 2003-2005. Peab Seicon Corporation (nowadays Peab Ltd.) was an international construction company in Finland that employed the author as a preparation step to facilitate the process of

entering the Iraqi market in 2003. The author is originally from Iraq and used to live in Finland for over 16 years. He possesses both languages; Arabic (the spoken language in Iraq) and Finnish. His qualification and experience in civil engineering and construction management is cumulative from both countries; Iraq and Finland.

The author was nominated by Peab Seicon Corporation as the official representative and liaise officer of the company in Iraq between June to December 2003 and between September to December 2005. The author was assisting the project export marketing of Peab Seicon for Iraq re-construction projects during that period. He was studying the potential construction projects in Iraq both from Finland and on site. He did all his duties initiative and established good relations with Iraqi clients and authorities and other international organisations in Iraq that were involved in Iraq re-construction projects, including:

- IO-UNICEF (Lead water and Sewage)
- DFID (Department of International Development)
- CPA (Coalition Provisional Authority)
- BECHTEL
- Misan Province and Municipalities

After investigating the requirements of entering the Iraqi national market, the first step was made by initiating the registration process of Peab Seicon Corporation as a company in the Iraqi Trade Ministry, which is a crucial step for international companies to work in Iraq. He also progressed the tax correspondent documentations and regulations with the Iraqi National Tax Service. Further, the author arranged the required paperwork with the Central Bank of Iraq to facilitate the financial transactions of the company from/to Iraq. After various negotiations, the author completed the background work to establish long term joint ventures between Peab Seicon Corporation and the local Iraqi companies. This can be performed between both partners in a way that the Finnish staff can transfer the needed technology to local Iraqi staff, such as by providing training. Moreover, the author has gathered business information about the building material procurements from local market as well as from neighbour countries market, including the shipping of these materials via Iraqi ports and national borders.

In summary, the author's experience as diaspora in Iraq was to act as the mediator between the Finnish company (Peab Seicon Corporation) and the local market in Iraq. Since the author is originally from Iraq, he utilised his awareness of the language and culture in Iraq to

facilitate various phases of introducing the company to the Iraqi market and to introduce the Iraqi clients and authorities to the Finnish company. The author played a key role in facilitating the negotiations about various business opportunities for the company in Iraq back then. Moreover, the author has passed the message of the Finnish company's spirit of partnership for the purpose of technology transfer to the Iraqi local staff to accomplish future projects together.

In analysis of the author's own experience as a Finn-Iraqi diaspora, different dimensions of observations can be obtained. As a positive side of this experience, there was significant impact on the time and efforts the Finnish company would have required to accomplish the same progress on the ground in Iraq if no diaspora (the author) was initially involved. The presence of diaspora as the first contact between the foreign company and the local market has provided a comfortable level of trust between the two parties. This trust is crucial to create business opportunities that would not be easy to maintain if no diaspora was involved. However, this level of trust may not be always the case with all diasporas in similar situations. For instance, it might happen that diasporas find kind of reluctant acceptance from the locals when returning home due to various cultural perspectives, such as questioning their loyalty or biasness. On the other hand, foreign companies may question the influence of locals on the diasporas by biasedly taking the locals' side during negotiating business opportunities. Things can be more complicated when diasporas unprofessionally exploit their role as mediators in business negotiations and may exaggerate or undermine certain aspects which may lead to significant misunderstanding in later stages of business arrangements.

Finally, it can be concluded from the two case studies covered earlier in this section, along with the author's own experience as diaspora, that it is important to consider the influence of language and culture on the success and the effectiveness of TT in international operations.

7.3 Single Case Study Overview

The single case study is the second pillar of the proposed tri-pillar research approach. Data collection for this study was undertaken Finnish construction professionals involved in the case project to be interviewed face-to-face. This study only solicited the perception of transferor (Finnish construction professionals) as transferee (host country local staff, Iraqis) was not allowed to be involved with Finns in construction project implementing.

The single case study targeting one of the most significant Finnish construction projects performed in Baghdad for the period 1978-1982. The case project chosen for the single case study is Baghdad Congress Palace (Figure 7.1).

The interviews conducted with six professionals involved including the project leader, technical manager, claims manager, assistant claims manager, construction manager and contracts manager of MALEMPO (table 7.1). JV MALEMPO undertook infrastructure works for Dorah housing project in Baghdad in 1976.

Table 7.1: List of people interviewed

Single case study (Baghdad Congress Palace) JV (IRCO-Group) December 2010,VTT, Finland, Otaniemi
(1) Project Leader of IRCO
(2) Contracts Manager (MALEMPO, Dorah Infra Pro)
(3) Construction Manager
(4) Technical Manager
(5) Claims Manager
(6) Assistant Claims Manager

7.3.1 Baghdad Congress Palace Building Project as a Single Case Study

The data gathered in this part comes mainly from interviews and some diaries of interviewees.

The palace is a building, conforming to the esteemed architectural inheritance of Iraq and it has a particular important position in the cultural and administrative life of present-day Iraq. The Baghdad Conference Palace was completed in summer of 1982 (See figure7.5).

The Iraqi Ministry of Planning organised an international architectural competition in the beginning of 1978. The winner of the competition was a Finnish architect named Heikki

Siren. The construction was the responsibility of a Joint Venture, IRCO-Group, formed by four Finnish building companies (Polar Construction Company, Lemminkäinen Oy, Oy Alfred A Palmberg Ab, and Teräsbetoni Oy). The first foundations of the building were laid on December, 1978. After four years, on July, 1982, the palace was officially handed over to the client. The final sum for the contract was around 230 million USD.

Figure 7.5. Baghdad Congress Palace photos (adopted from the palace guide, Kaija & Heikki Siren)

7.3.2 Interviews for Single Case Study

Owing to the nature of the qualitative data, the interview method was considered as the most appropriate. Key people involved in the case project were contacted in advance to confirm that they are willing to participate in the interviews as they are already retired. The key people agreed to participate in the interviews were senior managers involved in the case project: project leader, construction manager, technical manager, claims manager and technical claim preparation manager. Additionally, the contracts manager of Lemminkäinen Oy, which was the main partner of MALEMPO JV, was interviewed as a key expert who was involved in Dorah housing project in Baghdad 1976. He was also running the Project MALEMPO for Lemminkäinen until the contract of Baghdad Congress Palace was signed. The JV MALEMPO consists of Lemminkäinen Oy, Polar Oy, and an Iraqi businessman; Mr Al Makhzoumi, as a local partner. All these interviewees are senior experts with over 20 year experience in construction industry in general and over 10 years of experience in international construction operations. The interviewees have acted in key positions at the JV IRCO-Group

Then, the interview questions survey (see Appendix I) is set for the single case study sent via email to all six senior managers in advance. The interviews occurred in the VTT (Technical Research Centre) premises in Otaniemi, Espoo, in December 2010. The duration for every single interview was two hours and all interviews were recorded with interviewees' permission. Audio recording devices were provided by the VTT. Valuable specific details were written down from their own diary and case project documents. The interviews were conducted in English.

7.4 Key factors of the Interview in the Single Case Study

In order to constitute a strategy to gather the data from the interview conducted for the single case study, four key factors have been introduced. These four factors reflect the research hypotheses and the proposed TT model. In order to gather the data from the interview to highlight the importance of the role of diaspora, four key factors were introduced to reflect the interviewees' opinions about the need for diasporas in TT, as follows:

1. Involvement of Local Staff and Diasporas
2. Human centric factors bicultural and bilingual
3. Political constraints, i.e. political influence on decision making
4. Contractual agreement

7.5 Data Gathered from the Single Case Study

The gathered data is considered as of crucial value for this research since it is collected from senior managers involved within the case project except one of interviewees was informed about the phases of the case project as he was involved in another project performed in Baghdad at the time. When the Fins won the contract, the four Finnish companies mentioned earlier agreed to formulate the JV IRCO Group. The next four subsections will present the data gathered from the interviewee according to the four key factors mentioned earlier, which reflects what the six professionals have said in response to the questions of the interview.

7.5.1 Involvement of Local Staff and Diasporas

This section presents the response of the interviewees regarding the involvement of the Iraqi local staff and diasporas (if they have been involved) in the implementation phase of the project.

Project Leader:

"The use of local people and local subcontractors was only for Franki piling tasks, thereafter never of local people were involved, just those who were nominated by the government. They were nominated based on patronage and clientelism, as they were controlling and spying on us not for technical tasks. Diasporas involvement in future projects will in turn facilitate the TT and definitely avoid the misunderstanding led by cross-cultural matters."

Contracts Manager of MALEMPO:

"The project was based on political background, so the local people were not allowed to be involved. I was working in since 1976 for Dorah housing project, where Lemminkäinen was the partner of JV MALEMPO (MALEMPO formed from Lemminkäinen and Mohammed Al Makzoumi). Due to my previous experience with Iraq, I was not invited to Baghdad Congress Palace project. Even though, I was close to the project and I

was aware of what was going on, since I was working for Lemminkäinen at that time in Baghdad. As for diasporas, I think qualified diasporas, they can be absolutely helpful, if the use of diasporas for facilitating TT rather than for translation or interpretation."

Construction Manager:

"The political aspect was very clear which in turn imposes restrictions led to denial e.g. local staff to be involved within the case project due to security reasons. There was only a very limited group their role was just for monitoring us without any experience, as one of the concrete laboratory staff said that the supervisor of Iraqi side did not understand how to calculate the concrete cylinder area! The supervising staff were in fact just for spying on us and reporting all issues even our behaviours on the construction site to the Iraqi authorities. Also their tasks were for customs clearance and negotiation with local authorities for our accommodation. As for diaspora, of course, they can be very helpful in both TT process itself and in avoiding matters that might come up from cross-cultural issues."

Technical Manager:

"Local staff was banned to be involved with us to work in the project. It would be much better to avoid all cultural aspects, if diasporas would have been involved within."

Claims Manager:

"Local people were not allowed to be involved for political reasons. Diaspora is great idea, as they would really make the TT process much easier, because their abilities and possessing professional skills in addition to cultural and language skills."

Assistant claims Manager:

"The political aspects were very clear as the local staff which was very limited as small team for the supervision tasks, and the client was himself having a political background. Therefore, there was no real technology transfer process. The technology transfer lies only in the equipment and devices used in the project and local manpower e.g. craftsmen were not allowed to be involved within the project for political aspects. Regarding the diasporas, they would definitely enhance the technology transfer process as a whole due to their abilities and possessing bilingual and bicultural skills, further the latest qualifications."

7.5.2 Human Bicultural and Bilingual Factors

This factor addresses the attention of all interviewees who emphasised that language and cross-cultural impact on the case project process. Among these constraints was the continuous change in design in response to the whims of the client as well as the imposition of the British standards rather than European ones.

Project Leader:

"Human centric factors e.g. bicultural and bilingual are very important. I would say that people possessing such skills i.e. diasporas have excellent possibilities in facilitating TT process. The language aspect will definitely help us in avoiding the cross-cultural maters; further local people absorb knowledge and skills easily."

Contracts Manager of MALEMPO:

"Diaspora is able to help the process in terms of language and cross-cultural respects. If language can be translated, the culture is very difficult to adapt with. Diaspora is very important to solve the cross-cultural issues in the technology transfer process."

Construction Manager:

"The cultural impact was very present as the huge changes that showed remarkably when the president of Iraq commanded to make extension after a year of commencing the project. The extension commanded after Saddam's visit to Cuba for non-aligned states conference. We had to demolish foundations and soil works. Client representatives favoured BS (British Standards) over ES (European Standards) since the client was not aware about it. Furthermore, the religious principles and other cultural respects must to be carefully understood, and I believe that bilingual people can solve it smoothly. Next, technology transfer process is much easier, if it is done with native language."

Technical Manager:

"Language and culture should be very useful for technology transfer process. The second language is not enough to transfer technology, and culture is more important than language as Arab culture was not very known to Finns. When, we say that something is wrong, Arab man feels losing face. Cross-cultural is very important."

Claims Manager:

"I believe that the involvement of such people who have qualification from Finland or other country like us (Finns) will have a straightforward role to improve technology transfer process. Also, their role in culture and language impacts of avoiding obstacles. We did not know the local culture."

Assistant claims Manager:

"Employing diasporas within international operations is vital since their bilingual and bicultural skills can be efficient in facilitating technology transfer process. This is a good idea to involve such people. This was the same case with Russia, as Russians came first to get qualifications from Finland, thereafter went to Russia with Finnish companies. Diasporas

definitely facilitate the technology transfer process. Since such people possessing language and culture skills, the diasporas can be as a bridge to create mutual communications."

7.5.3 Political Intervention and its Limitations

The political factor reflects the influence of the local authorities on the TT process and its impact on the performance of the Finnish companies in the case project. The following statements from the interviewees show this aspect clearly:

Project Leader:

"I can say that the case project was carrying totally political background as it was targeting the seventh non-aligned states conference which was planned to be held in September 1982. We as management team and other technical staff were controlled by local supervisory staff nominated by Iraqi government. Next, the local people were not allowed to be involved in the case project."

Contracts Manager (MALEMPO):

"The case project was definitely political as people who had had experience of working in Iraq earlier were not allowed be involved. This was clearly evident as I was not invited for participating in Baghdad Congress Palace project. However, I was in that way attached that I was in charge of JV MALEMPO. I was the contracts manager working to Lemminkäinen which was the primary partner in JV of MALEMPO and one of the JV IRCO Group partner. The official reason that I was not involved is because the Iraqi government did not want to touch any foreign person who had had previous experience in Iraq."

Construction Manager:

"The project was targeting the non-aligned states conference which was expected to take place in September 1982 in Baghdad and for political aspect which in turn imposes restrictions led to denial e.g. local staff to be involved within the project due to security reasons. There was only very limited group their role was just for controlling us without any experience.. Further, I noted by chance in the basement level was very top secret tape recorder centre for the incoming and outgoing phone calls in the palace. The local staff was rather totally banned to be involved with us. Further, engineers of the management team were getting their jobs by their parent or relations to the government as they were nominated based on political background."

Technical Manager:

"It is a political project as it was targeting the seventh non-aligned states conference and Saddam wanted to show his power."

Claims Manager:

"The project was for non-aligned states seventh conference was to be held in September 1982. Further, the decision of banning local people to be hired in the project has given a significant sign that the project was totally political."

Assistant Claims Manager:

"The project was very political in sense; it was meant that Saddam wanted to show peace as the project was targeting the seventh non-aliened states conference which was expected to be held in Baghdad in September 1982. The political aspects were very clear as the local staff which was very limited as small team for the supervisory tasks, and the client (i.e. the government of Iraq) was itself a political body."

7.5.4 Contractual Agreement

The contractual agreement factor reflects the lack of incorporating certain paragraphs in the main contractual agreement to indicate the TT conditions. For instance, there were general clauses for this purpose, such as the equipment and devices have to be best in the world.

The contractual agreement has significant impact on the knowledge and TT process, which should be utilised to highlight the strong tie between the diaspora involvement and local staff training in the TT process.

Project Leader:

"Contract was including such odd article that local people and Arabs are not allowed to be involved in the case project. Therefore, there were not technology transfer practices."

Contracts Manager of MALEMPO:

"Instead of including specific terms in relation to technology transfer, in contrast, there were ban terms included the concern of keeping local people away from being involved within the project."

Construction Manager:

"Due to the contract nature, there was no inclusion of any item or term regarding TT process. This was very clear as we were not allowed to hire local manpower and not to purchase materials and equipment; only cement, sand and gravel were allowed. Further, there was unclear clauses such as (the equipments, devices and all materials have to be the best in the world) such clause was open, can not be achieved, therefore, the project was unprofitable itself, the contract cost increased to be four fold."

Technical Manager:

"There was no term regarding the technology transfer process. The contract was not agreed in a clear manner."

Claims Manager:

"The contract was not allowed to employ Iraqis, not to use local market materials, equipment and others. The only materials that could be purchased from the local market were sand, cement and gravel."

Assistant Claims Manager:

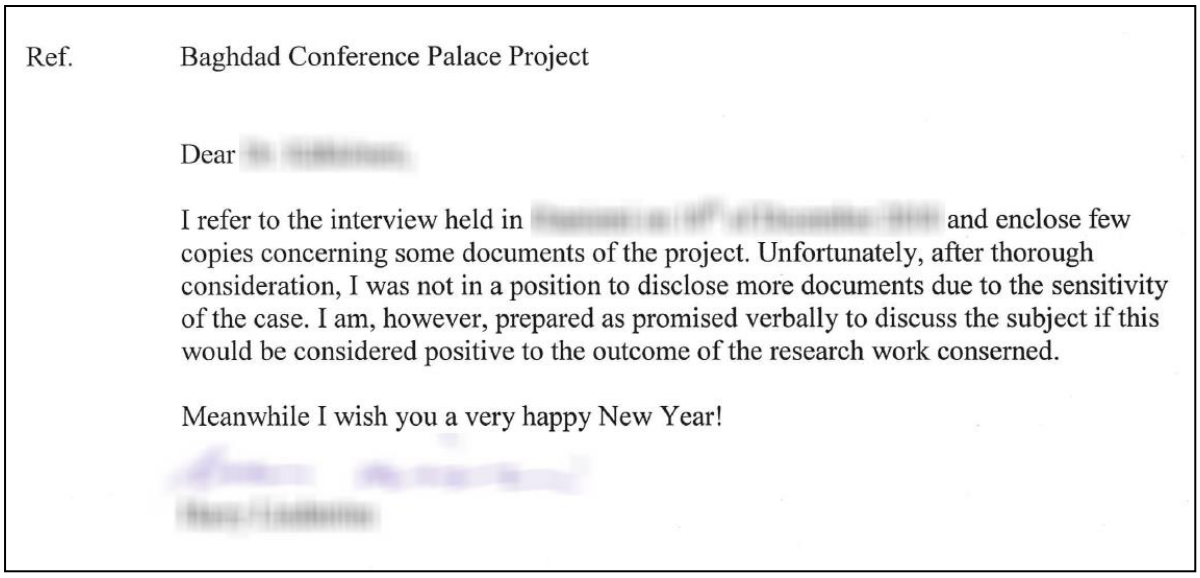
"The project building was for political aspects that hindered technology transfer components to be used. Therefore, it was not a real technology transfer process. The technology transfer lies only in the equipment and devices used in the project, while local manpower e.g. craftsmen were not allowed to be involved within the project for political aspects. Regarding the diasporas, they would definitely enhance the technology transfer process as a whole due to their abilities and possessing bilingual and bicultural skills as well as the latest qualifications."

7.6 Discussion of Findings from the SC

As it can be noticed from the gathered data in the previous section, there are four main streams that can be identified to measure the impact of international construction projects (e.g. the Baghdad Congress Palace project) on the TT process. The responses from the candidates have shown that there was a gap between the implementation process and the engagement of the client.

- *Involvement of Local Staff and Diasporas:*

The first factor, which is the involvement of local staff and diasporas, was subject to the decision of the Iraqi government that was extremely concerned about the confidentiality of the project. There was no participation from the local professionals neither from the local manpower to engage in the details of the implementation of the project. The Iraqi government has imposed highly restricted constraints on the Finns in order not to disclose any information relevant to the project. This was clearly noticed when the interviewees were asked about the project details, then could not reveal everything they know. An example of this confidentiality concern was reflected in a letter received from one interviewee hesitated to provide documents about the project implementation (figure 7.6).



Ref. Baghdad Conference Palace Project

Dear [redacted]

I refer to the interview held in [redacted] and enclose few copies concerning some documents of the project. Unfortunately, after thorough consideration, I was not in a position to disclose more documents due to the sensitivity of the case. I am, however, prepared as promised verbally to discuss the subject if this would be considered positive to the outcome of the research work conserned.

Meanwhile I wish you a very happy New Year!

[redacted]

Figure 7.6: A letter received from one of the interviewees indicating his concern about disclosing sensitive documents related to Baghdad Congress Palace Project.

- *Human centric factors bicultural and bilingual*

The second factor is related to the obstacles resulted from the language and cultural differences between the Finns professionals and the Iraqis. The language problem was partially solved by hiring local interpreters and using the English language, which was somehow known to Iraqis. However, the cultural barrier was significantly apparent due to the lack of intellectual communication with the client. For instance, Iraqis tend to consider the American construction standard is the best reliable one to follow. Therefore, it was difficult to convince them that the Finns have their own standard, which is the European standard. Moreover, from the Iraqi culture, it is common to use vague sentences like '***the best equipment in the world***' to refer to the highest standard in the international market for a particular equipment, though Iraqis do not have industrial awareness of how to obtain the technical characteristics information to use it to inspect the imported materials. This has caused occasional misunderstanding when the Finns were negotiating the contract with the Iraqis to clear such vague clauses

Dr Palojärvi being one of interviewees stated that any language can be learnt by few years, whereas full adoption of any culture requires even tens of decades. This factor has a significant impact on the technology transfer process. This is confirmed by the interviewees by stating that cross-cultural and language issues have a centric impact on the TT process as a whole. The following reflects the interviewees' feedback on the language and culture aspects.

- *Political constraints*

The third factor is related to the influence of the government on the construction process of the project. For instance, when President Hussein came back from his visit to Cuba during the time of the project, he instructed the Finns to add an extension to the plan. This happened after one year of starting the construction of the project, which has affected the work plan that was already agreed and signed in the contract. Moreover, due to President Hussein's no-trust relationship with the west, the Finns have experienced inconvenient working circumstances represented by the continuous surveillance and spying from the local authorities. Furthermore, the war with Iraq that started during the period of implementing the project has affected the Finns due to the safety concern, the foreign manpower running away from the country, and the general disturbed mood of the client (the government) because of the war conditions. Figure 7.7 shows one of the documents that luckily was given by one of the interviewees that reflects the decline in the work progress on the start of the war between Iraq and Iran in September 1980.

- *Contractual agreement*

Finally, the contractual agreement factor has not mentioned any clauses that consider the importance of knowledge or technology transfer to the local staff. The contract did not include any training while or after the project implementation. However, there was only a condition of training local staff to operate the palace when the project is done. This has not given any opportunity for Iraqis to learn the technology behind the building of a remarkable establishment in their own country that took four years on the ground.

In conclusion, the gathered data from the single case study has shown no evidence of any knowledge and technology transfer to the local community in Iraq as a developing country. Although this had no 'obvious' impact on the success of implementing the project eventually; however, it would have had a significant impact on the construction industry in Iraq. If local staff have been involved in such a large scale construction project like the Baghdad Congress Palace project, there would have been numerous jobs created and the Iraqi local staff would have gained high standard construction experience. Moreover, if Finn-Iraqis diasporas were seriously involved throughout the project phases (planning and implementation), they would have bridged the gap of language and culture differences between Finns and Iraqis, leading to clarifying the occasional misunderstandings occurred due to the lack of cultural awareness. Therefore, the involvement of local staff and diasporas would surely have made significant impact on the project implementation itself as well as on the local industry of the transferee country; Iraq. As a result of the SC, it can be concluded that the human centric factors can directly enable of TT process. This supports the hypotheses of this research and represents successful evidence in proving the validity of its context. Furthermore, the justification of exploring the single case study has proved that the conceptual model of this study can provide an approach to facilitate the TT process when the KTI involvement is seriously considered to mediate between the transferor and the transferee.

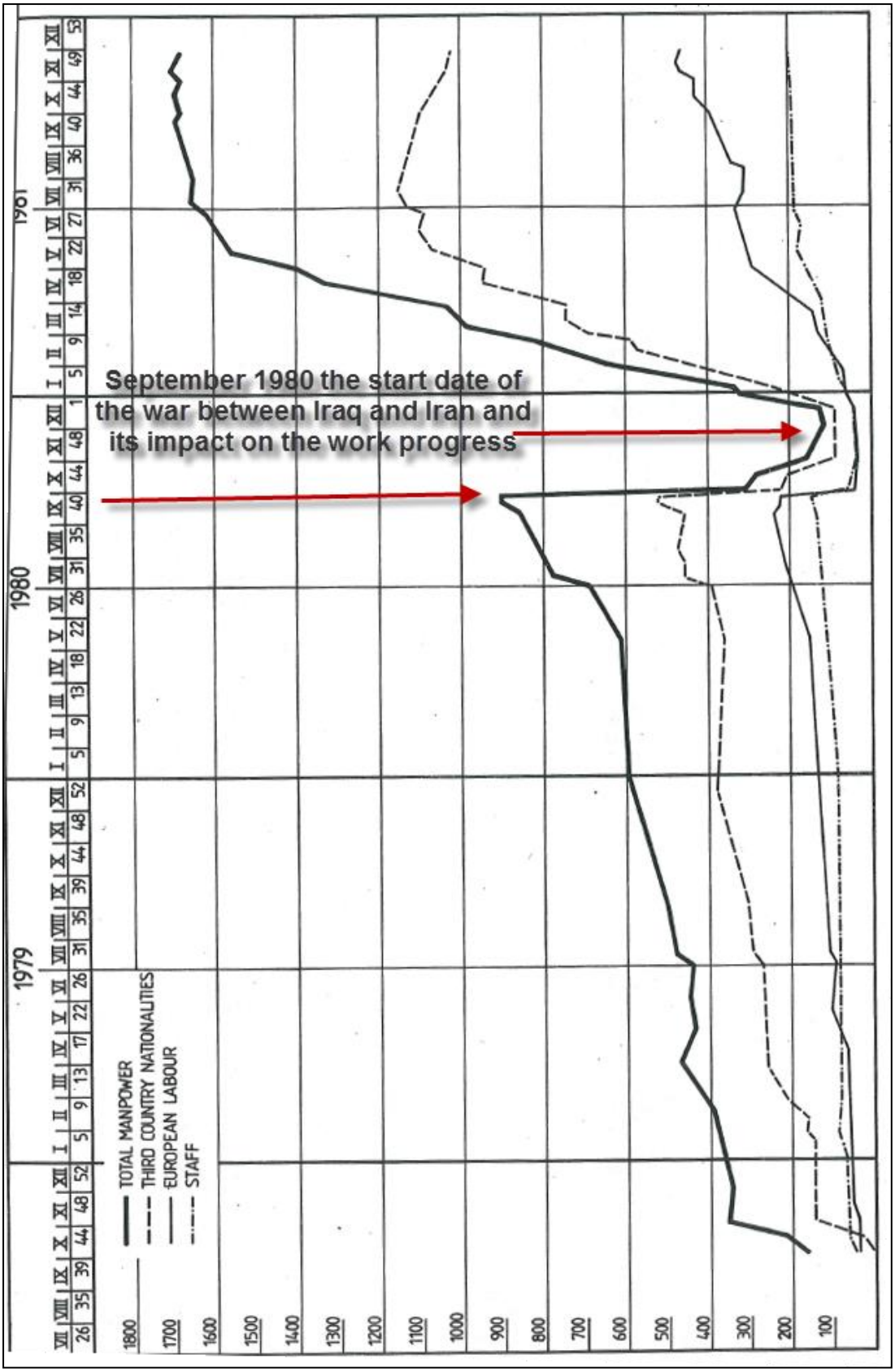


Figure 7.7: A document received from one of the interviewees showing the decline of the work progress straight after starting the war between Iraq and Iran in September 1980.

7.7 Multi-Case Study Overview

The multi-case study is the third pillar of the selected tri-pillar research approach. Accordingly, the quantitative data collection is a tool to enhance and further support the research. In the quantitative data approach for multi-case study, the objective is to cover as many construction projects as possible that were completed by Finnish companies in Iraq during the period of 1970's and 1980's (see figure 7.8).

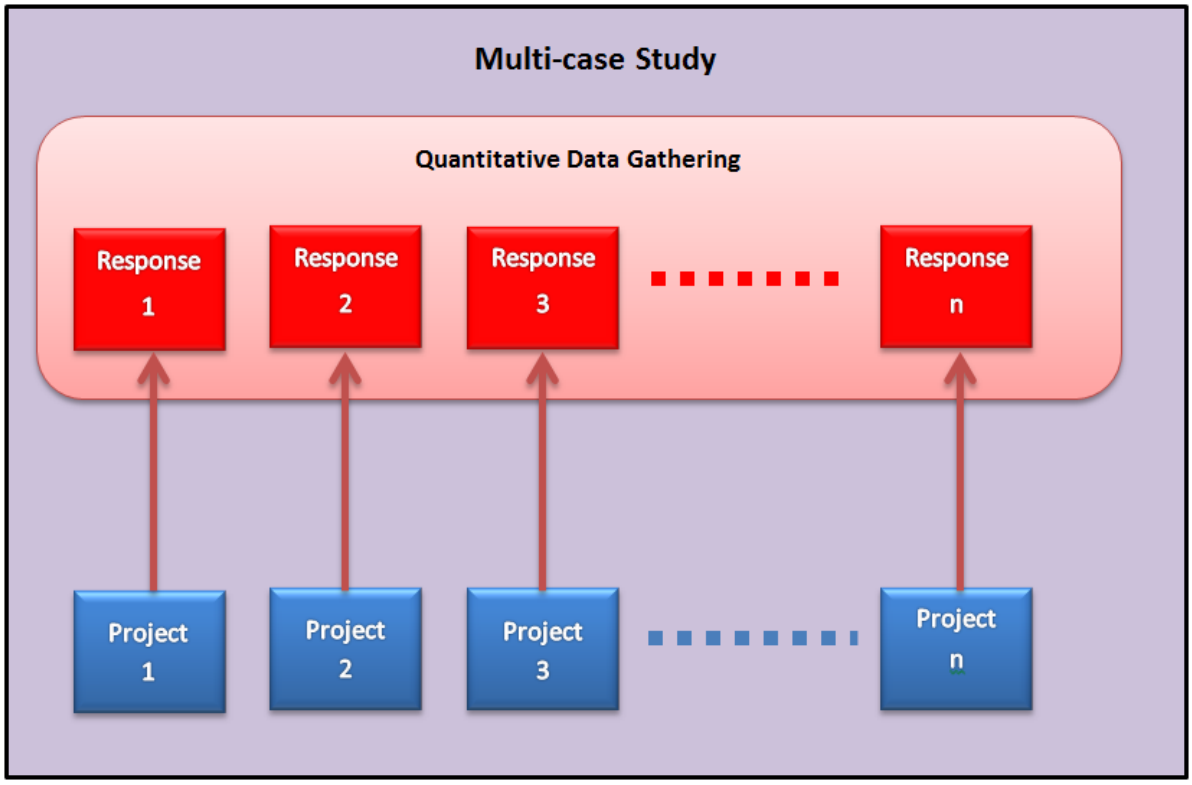


Figure 7.8. Multi-Case Study taken from construction projects undertaken by Finnish companies in Iraq

In the 1970s and 1980s Finnish construction companies entered into Iraq as part of their strategy to widen the international export markets (see figure 7.9).

A questionnaire for the survey was prepared based on the proposed DTT model. The questionnaire survey form (see Appendix II) was electronically by email sent to the all professionals who initially agreed to participate. It was expected that the use of electronic media would have facilitated and accelerated the research process

Figure 7.9: The map of construction projects performed by Finnish companies during 1970's and 1980's (source: Helsingin Sanomat Finnish newspaper, 2002)

It is noticeable that all professionals involved in the construction projects performed by Finnish companies for the period of 1970's and 1980's are mostly retired at the time of this research. Therefore, it was a somewhat difficult to obtain or hunt their contact details. Consequently, the questionnaire forms were only sent to those who could be reached. The survey was conducted during the period from July to December 2010.

7.8 Data Gathered from the Multi-Case Study

The multi-case study is about the construction and other industrial projects done in Iraq by Finnish companies for the periods of 1970's and 1980's. For this task, an electronic survey was conducted and sent to professionals via emails.

It is worth to indicate that the targeted professionals who were involved in the projects for the period of the research interest have either retired or passed away. Therefore, the author of this research has made exceptional attempts and efforts in terms of time, cost and travelling, and has investigated various contacts to reach the targeted group to collect as many responses as possible. The contacts were made from one professional to another in a chain-like manner. The companies in which the professionals used to work have been contacted in order to seek contacts of the professionals, though all attempts were rejected due to the privacy policy in Finland. The survey was sent to over 20 Finns professionals, yet, only eight of them have responded. Table 7.2 states general information about the candidates who have participated in responding to the multi-case study questionnaire.

Table 7.2: General information about the Finnish professionals who responded to the MC survey (part A of the survey)

Candidate No.	Project Description	Position	Type of Organisation	Years of Construction Experience	Number of International Projects
1	Perasto Civil Defence Shelters	Site & Consulting Engineer	Main Contractor	20+	6-9
2	IRR, Structural percast concrete framework for railway buildings between Baghdad -Al Qaim- Akashat	Project Manager & Project Engineer	Sub-contractor	20+	6-9
3	Dorah Housing Projects of MALEMPO 1976-1984	Contracts Manager	Main Contractor	20+	10+
4	Akashat-AlQaim Housin Project	Production Manager	Sub-contractor	20+	2-5
5	Diesel Power Plants projects in Iraq	Project Manager	Main Contractor	11-15	10+
6	Joint-Venture to build 28 Industrial Schools and 6 Technical Agricultural institutes in 34 different locations in Iraq, on turn-key basis.	Project Manager	Main Contractor	20+	10+
7	Confidential project	Construction Manager	Main Contractor	20+	1
8	Confidential project	Site Engineer	Main Contractor	20+	2-5

It is important to address that the number of candidates who agreed is much less that we the author hoped for. This is because many Finns professionals were cautious to participate in the survey due to the sensitive nature of the projects they were involved in at that period in Iraq, including military, defence and security projects, which require high level of confidentiality. Although a new government has been established in Iraq, the professionals could not reveal the nature of these projects for ethical and political reasons they did not want to mention.
Nevertheless, the findings of the analysing process performed were satisfactory in a sense that leads to results fulfilling the objectives of this study (see chapter 8).
The gathered data from the questionnaire of the multi-case study can be illustrated as below to reflect the statistics of the collected responses from the professionals involved in the survey. The graphic grading used follows the following scale for ranking options:

1	2	3	4	5
Very Low / Poor	*Low / Poor*	*Adequate / Satisfactory*	*High / Good*	*Very High / Very Good*
Highly inappropriate	Inappropriate	*Satisfactory*	Appropriate	Highly appropriate

7.8.1 Evaluation of International TT when the Traditional Approach was Applied

Table 7.3 and figure 7.10 demonstrate the evaluation of the international TT when the traditional (horizontal transfer) approach was applied.

Table 7.3: The relevant questions of Part B in the survey.

Abbreviation	Questions
B1	Transfer mode was inappropriate choice
B2	Government policy and enforcement (influence)
B3	Language and culture differences
B4	Trust local partner
B5	Education level of local employees
B6	Local employees involvement
B7	Economic environment
B8	Transferors willingness to release their skills
B9	Fears of local partner competence
B10	Training of local staff
B11	Contractual agreement (not long term partnership e.g. turnkey)

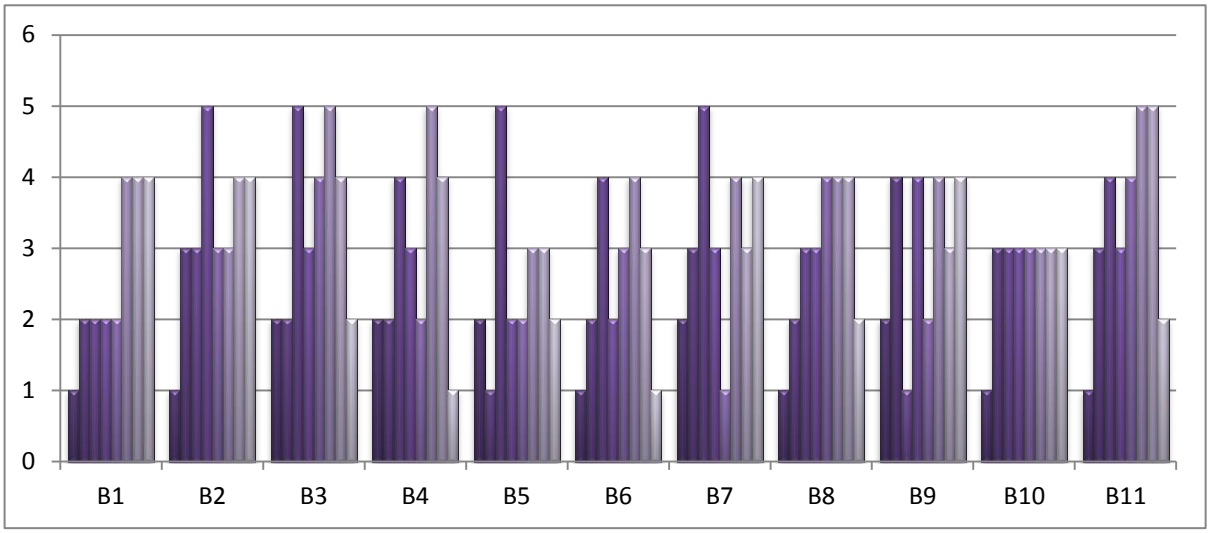


Figure 7.10: The illustration of the gathered data for Part B in the survey.

7.8.2 Evaluation of the New International DTT Model

Table 7.4 and figure 7.11 demonstrate **Transfer Environment (TE):** this is subjected to the transferee's local environment including economic development, Gross Domestic Product (GDP) and government policy and enforcement practices.

Table 7.4: The relevant questions of Transfer Environment (TE) section in Part D of the survey.

Abbreviation	Questions
TE-1	Economic development & Gross Domestic Product
TE-2	Government policy & enforcement practices

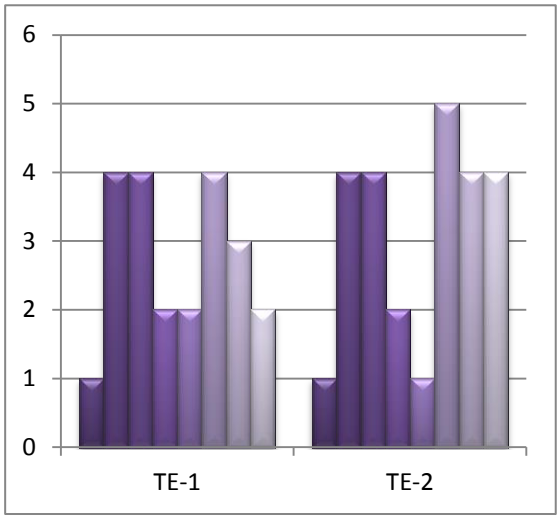


Figure 7.11: The illustration of the gathered data for TE section in Part D of the survey.

Table 7.5 and figure 7.12 demonstrate whether the **Fin-Companies (FC)** were concerned with the degree of willingness to transfer the required knowledge.

Table 7.5: The relevant questions of Fin-Companies (FC) section in Part C of the survey.

Abbreviation	Questions
FC-1	Diasporas involvement
FC-2	Previous international experience
FC-3	willing to train local staff

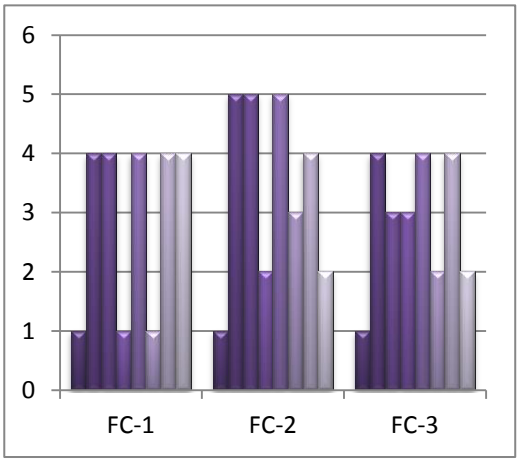


Figure 7.12: The illustration of the gathered data for FC section in the Part C of the survey.

Table 7.5 and figure 7.13 demonstrate the **Knowledge and Technology Integrator (KTI)** (Diasporas = Finn-Iraqis), which concerned with the degree to which the willing of Finnish companies to qualify diasporas with latest technology and getting benefit of their skills of bilingual and bicultural to play as a moderate between Finnish and Iraqi collaboration..

Table 7.6: The relevant questions of Contractual Agreement (KTI) section in Part C of the survey.

Abbreviation	Questions
KTI-1	Transferring latest technology qualification
KTI-2	Bilingual (overcoming language barriers)
KTI-3	Bicultural (overcoming culture barriers)
KTI-4	Enhancing relationship between transferor and transferee

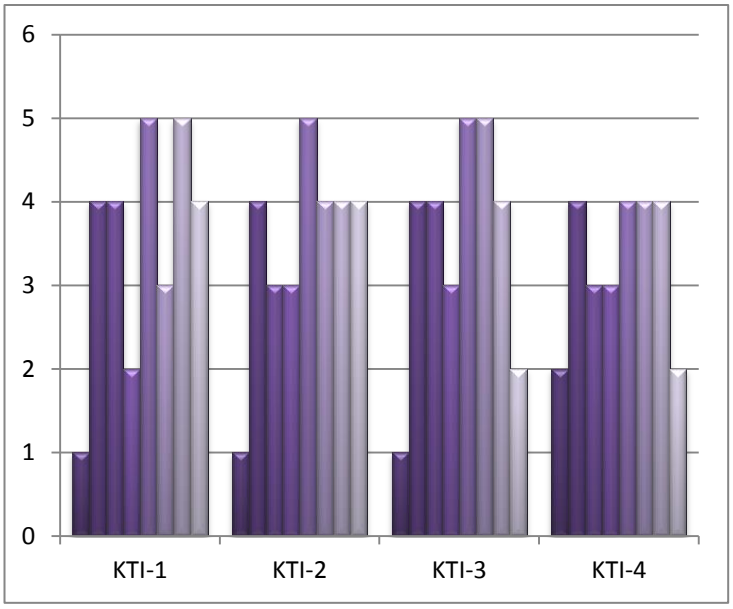


Figure 7.13: The illustration of the gathered data for KTI section in Part C of the survey.

Table 7.7 and figure 7.14 demonstrate the **Contractual Agreement (CA)** (Long term, transfer mode): this is subjected to the degree to which the vehicle of transfer facilitates the knowledge and technology transfer and concerned with the degree to which the host (Iraqi) government commitment to give assurances to transferor and investor within Foreign Direct Investment (FDI) initiatives.

Table 7.7: The relevant questions of Contractual Agreement (CA) section in Part C of the survey.

Abbreviation	Questions
CA-1	Government commitment
CA-2	Investment Law of Iraq
CA-3	Transfer Mechanism
CA-4	Joint venture (long term agreement)
CA-5	Turnkey contract
CA-6	Licensing
CA-7	Franchising
CA-8	Sub-contracting
CA-9	Integrated packages
CA-10	Other

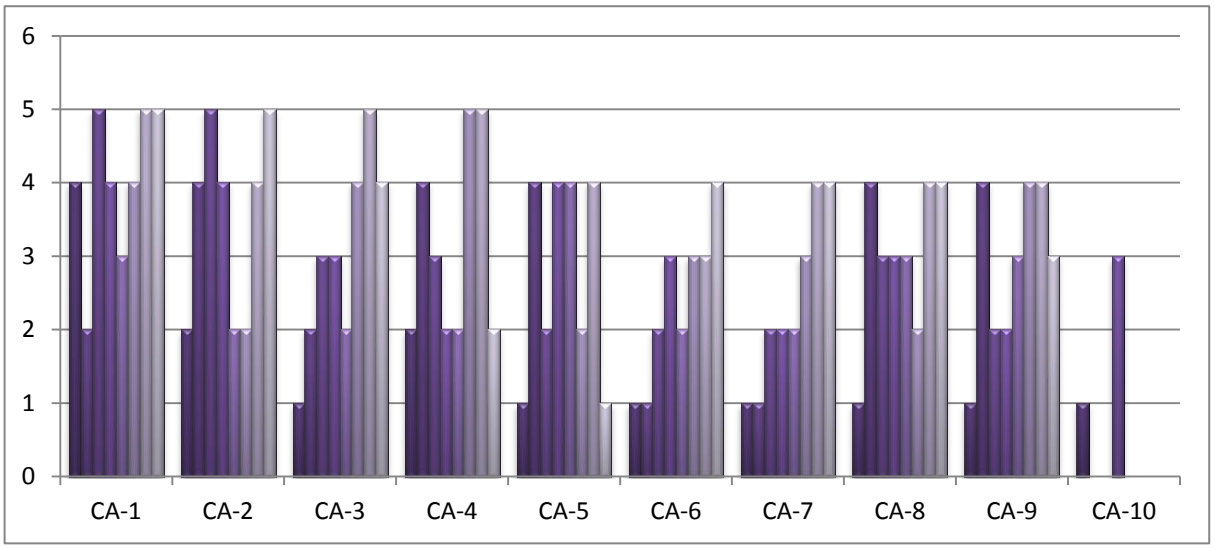


Figure 7.14: The illustration of the gathered data for CA section in Part C of the survey.

Table 7.8 and figure 7.15 demonstrate the **University-Industry Collaboration (UIC) and R&D:** this is subjected to the degree to which Iraqi government undertakes to establish research centres and set a strategy of collaboration between universities and industry in Iraq.

Table 7.8: The relevant questions of University-Industry Collaboration (UIC) section in Part C of the survey.

Abbreviation	Questions
UIC-1	Government support (funding)
UIC-2	Private sector infrastructure
UIC-3	Proximity dimensions

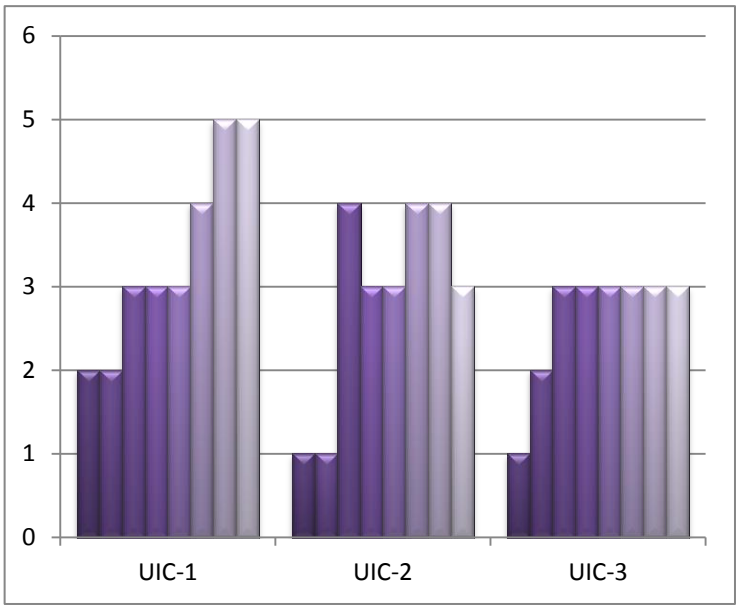


Figure 7.15: The illustration of the gathered data for UIC section in Part C of the survey.

Table 7.9 and figure 7.16 demonstrate **Knowledge and Technology Acquisition (KTA):** this is subjected to the degree to which local labours improve their skills and efficiency by new knowledge and technology acquisition to be qualified for further projects.

Table 7.9: The relevant questions of Knowledge and Technology Acquisition (KTA) section in Part C of the survey.

Abbreviation	Questions
KTA-1	Choice & need of technology
KTA-2	Nature & complexity of technology
KTA-3	Communication
KTA-4	Training and acquisition ability
KTA-5	Economic environment
KTA-6	Political environment

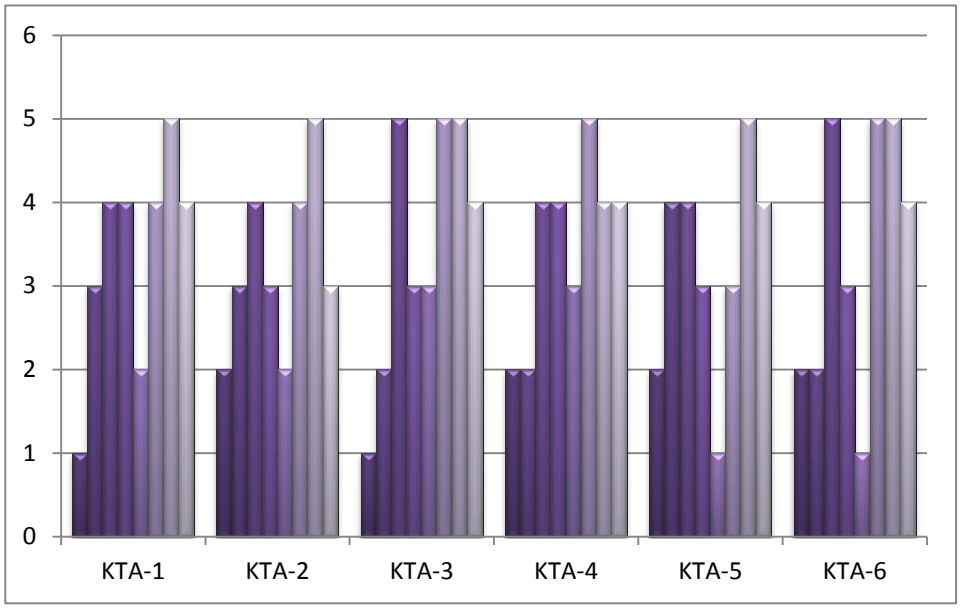


Figure 7.16: The illustration of the gathered data for KTA section in Part C of the survey.

Table 7.10 and figure 7.17 demonstrate **Public & Private Sectors (PPS) of Iraq:** this is subjected to the degree to which acquisition ability of local employees.

Table 7.10: The relevant questions of Public & Private Sectors (PPS) section in Part C of the survey.

Abbreviation	Questions
PPS-1	Willing to learning
PPS-2	Acquisition ability

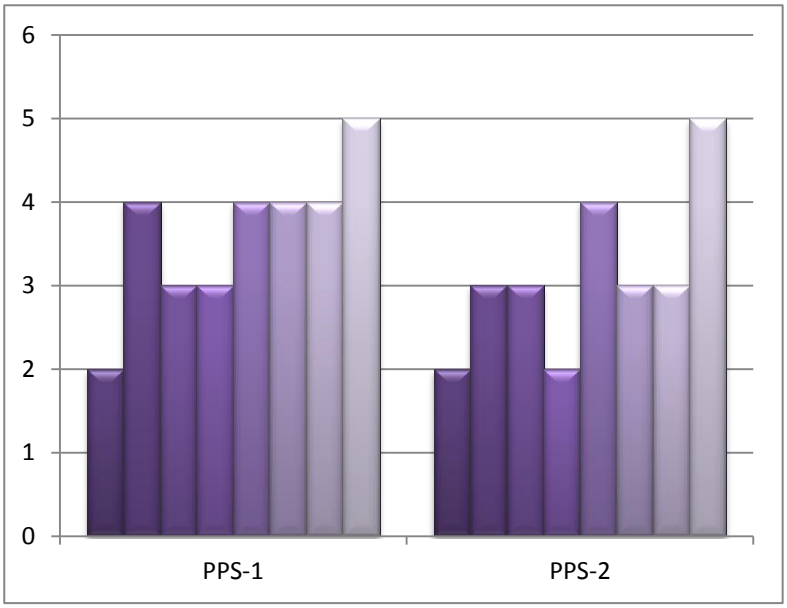


Figure7.17: The illustration of the gathered data for PPS section in Part C of the survey.

Table 7.11 and figure 7.18 demonstrate **Project Performance (PP):** this is subjected to the degree to which the success of the overall performance in construction projects delivery should result from effective TT.

Table 7.11: The relevant questions of Project Performance (PP) section in Part D of the survey.

Abbreviation	Questions
PP-1	Domestic industry balance
PP-2	Improved working practices
PP-3	Schedule performance
PP-4	Financial performance

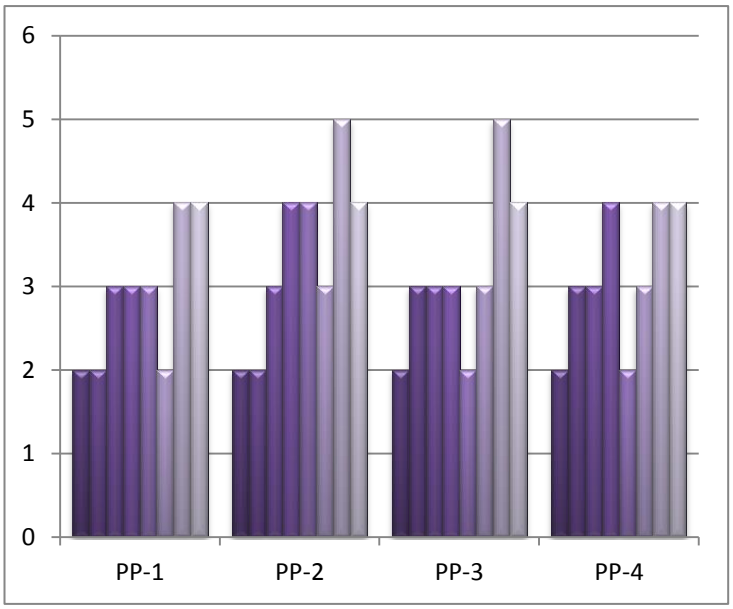


Figure 7.18: The illustration of the gathered data for PP section in Part D of the survey.

Table 7.12 and figure 7.19 demonstrate **Knowledge Resettlement and Integration (KRI):** this is subjected to the degree to which knowledge absorbed by local staff from developed country.

Table 7.12: The relevant questions of Knowledge Resettlement and Integration (KRI) section in Part D of the survey.

Abbreviation	Questions
KRI-1	Improved knowledge
KRI-2	Knowledge gap
KRI-3	Training and taught courses
KRI-4	Long-term adoption of transferred skills

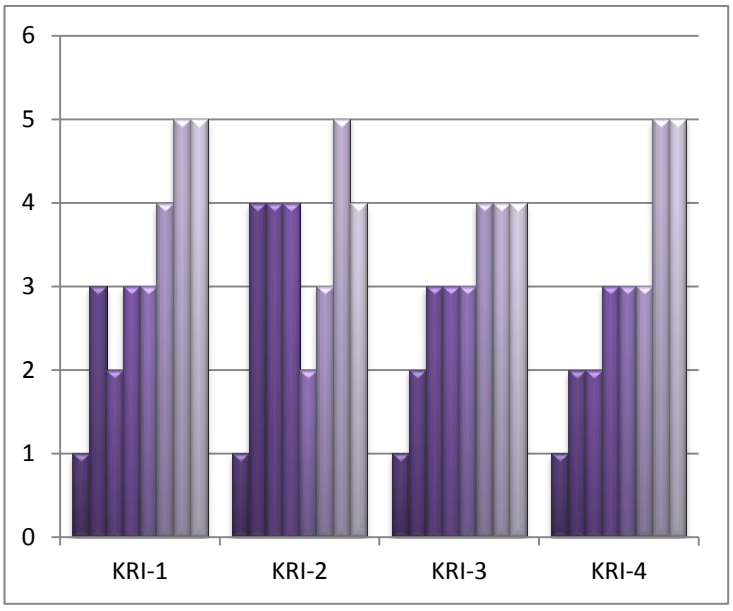


Figure 7.19: The illustration of the gathered data for KRI section in Part D of the survey.

Table 7.13 and figure 7.20 demonstrate **Return Migration (RM) – (Diasporas qualified Iraqis living abroad):** this is subjected to the degree to which Diasporas 'migrant brains' return back to their home land in order to participate in rebuilding projects.

Table 7.13: The relevant questions of Return Migration (RM) section in Part D of the survey.

Abbreviation	Questions
RM-1	Socialisation (Tacit Knowledge: Tacit-Tacit)
RM-2	Qualified workers return to their homeland
RM-3	Knowledge settlement
RM-4	Eliminate privileged foreign elite

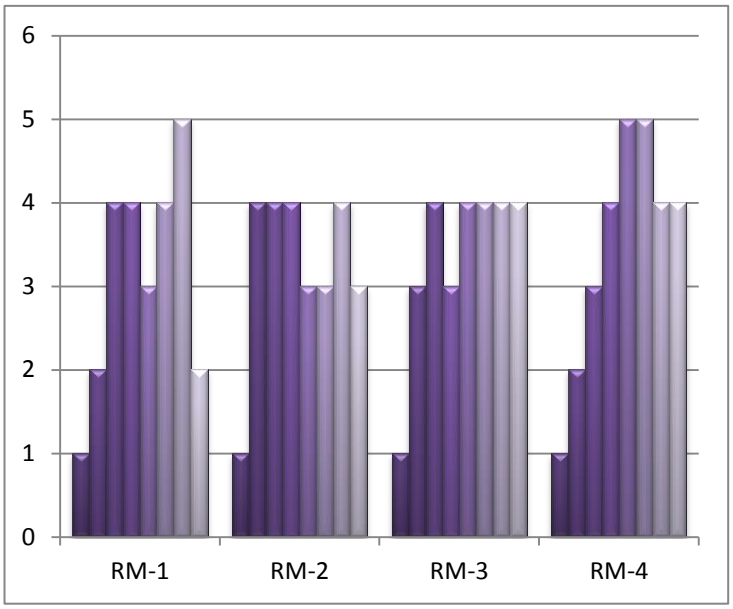


Figure 7.20: The illustration of the gathered data for RM section in Part D of the survey.

Table 7.14 and figure 7.21 demonstrate **Economic Advancement (EA):** this is subjected to the degree to which TT programmes have improved the competitiveness of host firms in the domestic and international market and with the degree to which TT programmes have enabled the transferee to perform at a higher level.

Table 7.14: The relevant questions of Economic Advancement (EA) section in Part D of the survey.

Abbreviation	Questions
EA-1	Competitiveness
EA-2	New market
EA-3	Performance improvement

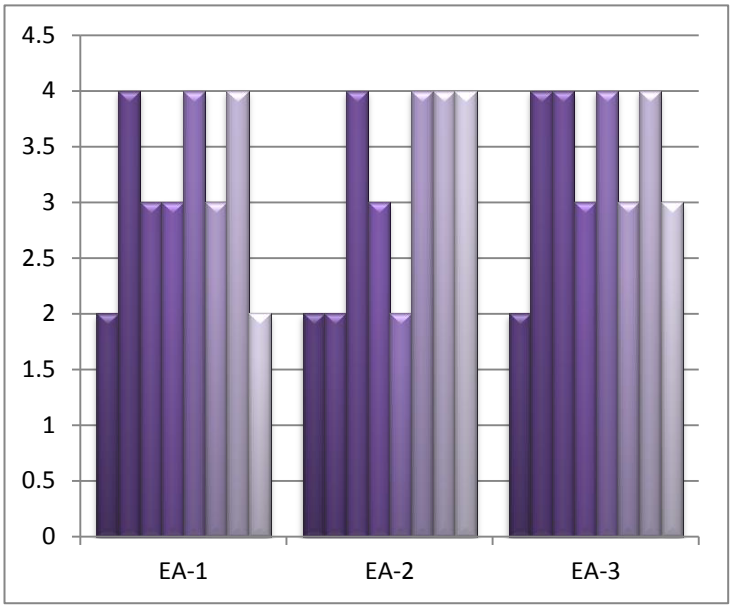


Figure 7.21: The illustration of the gathered data for EA section in Part D of the survey.

7.9 Discussion of Findings from the MC

The findings of the MC study showed various aspects regarding the perspective of the Finnish companies in terms of knowledge and technology transfer while working in Iraq in the mentioned two decades. This included the following:

- Willingness to transfer the required knowledge to local staff.
- Knowledge and technology integrator KTI and the willingness of Finnish companies to qualify diasporas.
- Contractual agreement and its impact on the TT process.
- University-Industry collaboration and its relation to enhance the research and development with the client.
- Knowledge and technology acquisition by the local staff.
- Public and private sectors and its role in accelerating the TT process by establishing a reliable long-term cooperative practice, e.g. joint ventures.
- The reliance of TT process on having a suitable transfer environment that facilitates the delivery of knowledge, including stable politics and emerging economy.
- The project performance is the indicator of how the TT will improve the local capability to run and operate future projects independently.
- Knowledge resettlement and integration by providing further training and establishing long-term business relationships to bridge the gap in transferring knowledge and international skills to the local staff.
- Return migration of diasporas qualified Iraqis living abroad to homeland and participate in rebuilding their country.
- Economic advancement for both transferor and transferee by creating new market and increasing the potential of domestic business opportunities.

Finally, it is worth to mention that it was interesting to see some significant variance in some answers of the respondents of the MC questionnaire regarding some questions. For instance, B11 (Contractual agreement) in figure 7.10 where both scores 1 and 5 appeared, and FC-1 (Diasporas involvement) in figure 7.12 were three 1's and five 4's appeared. This can only be explained by the different experience of the experts (participants) while working in Iraq at that time. This gives an indication that there were certain circumstances back then that resulted in making the experts' opinions vary towards the same questions.

7.10 Summary

This chapter has presented the findings of the single case study and the multi-case study, which represent the second and the third pillars of the proposed tri-pillar research approach. The gathered data of the single case study (SC) was collected from the responses of the face-to-face interviews with the professionals who participated in constructing the Baghdad Congress Palace building. The gathered data of the multi-case study (MC) was collected from the responses of the survey study, which was electronically sent to a target group of professionals who worked in Iraq in various construction projects during the period of 1970's and 1980's. The SC data gathering focused on four main factors that support the hypotheses of this research, while the MC data gathering aimed to highlighted wider aspects related to the TT process from the perspectives of professional Finns. The two sets of findings from SC and MC were discussed to emphasis the key links between the case studies and the conducted research in the previous chapters. The next chapter will analyse, discuss, and evaluate the overall findings from both the SC and MC case studies, and will eventually prove the validity of this research approach in achieving the anticipated objectives.

CHAPTER 8

ANALYSIS, DISCUSSION AND CRITIQUES

8.1 Introduction

The aim of this chapter is to analyse and evaluate the findings of both the interviews of the six involved professional in Baghdad Congress Palace and the questionnaire that was sent to professionals involved in construction and other industrial projects in Iraq in 1970's and 1980's. Both findings of the single case study and the multi-case study representatives are incorporated to the analysis. According to the observations from the previous chapter, it was clear that there is a crucial need to understand how construction TT process is managed in practice between developed and developing countries. Both case studies are described and analysed separately to reflect in the literature review and the two hypotheses of this study.

This chapter starts by identifying the analysis approaches of the SC and MC case studies. Then, the findings of the SC case study will be analysed in details, which will include inductive analysis of the four main factors involved. This will be followed by a discussion on the SC analysis. After that, the findings of the MC case study will be analysed, which helped to closely examine the quantitative tables conducted from the MC questionnaire. This will also be followed by a dedicated section for discussion and critiques. This section will include an intensive discussion to establish a solid connection between the findings of the three pillars of this study (literature review, SC and MC) in supporting the proposed DTT model. This will be accomplished by discussing and criticising the research three pillars in terms of conducting internal validity, external validity, reliability, objectivity versus subjectivity, and applicability of the DTT model, which in turn will satisfy the hypotheses of this research.

8.2 Analysis Approaches of the SC and MC Studies

In order to examine the validity of the proposed DTT model, the two case studies that were conducted in the previous chapter need to be carefully analysed and evaluated. There are two approaches have been applied in the analysis. The first approach is the *Inductive Analysis* to be applied on the SC to analyse the qualitative data gathered. The second approach is the *Statistical Analysis* to be applied on the MC to analyse the quantitative data gathered.

The inductive analysis approach is based on gathering qualitative data and analysing it based on the obvious logic that can be generalised from the findings. There are different types of inductive reasoning, such as generalisation, statistical syllogism, simple induction, argument from analogy, causal inference, and prediction. Inductive reasoning/logic has been through prolonged arguments that questioned the reliability of inductive results to be considered as evidence to prove absolute certain facts. However, inductive analysis stands as a well-known analytic approach that can confidently construct propositions abstracted from general observations, especially in scientific research, philosophy and other humanitarian sciences.

The SC findings will be analysed using the inductive analysis approach by thoroughly examining the gathered data of the face-to-face interviews. The analysis will show the impacts of not considering the local staff and diasporas involvement, bicultural and bilingual factors, political influence, and contractual agreement on TT process. This will be followed by a general discussion on the main remarks that can be concluded from the SC inductive analysis.

On the other hand, the MC quantitative data gathered will be analysed using the statistical analysis approach. In this approach, there are three inductors used to assess the measurements factors of the MC. These inductors are namely T-test, median and correlation, which were used as a manner of interpreting the analysed data.

8.3 Single Case Study Analysis

In the SC, the interviewees represent professional Finns who were involved in construction projects in Iraq. Although the sample of candidates is relatively small (table 7.1 in chapter 7), the comments and feedbacks reflect the vision of former project leader and managers of the Finnish companies in that period, which significant remarkable experience in the construction field. This compromise between the number of interviewees from one side, and their high qualification and positions in the case project on the other side, has provided strong indication that can be reliable to generalise the reasoning behind the proposed model of the international TT process.

This section will provide the necessary analysis of the single case study for Baghdad Congress Palace. The analysis approach is based on inductive research method that will be used to conclude general findings of the interviews pattern, which will be discussed in details in the next four subsections.

8.3.1 Analysis of the Impact of Involvement by Local Staff and Diasporas

The perceived lack of local staff involvement came up in various comments from interviewees. According to the interviewees, it was noticed that the local staff were not allowed to be involved within case project due to high security measures imposed on the project as a whole. Iraqi government did not trust Iraqis to get involved in this project, while only a small group nominated by the vice-president for national security purposes. This group had political background therefore they were authorised for controlling, reporting project progress to the politicians and custom clearing.

Local staff: As mentioned earlier, equipment, tools and materials are not enough for TT process to occur. One of the approaches to get local staff qualified and skilled is to be involved throughout the construction project phases, in addition to providing the necessary education and training.

To inductively analyse the gathered data of the SC regarding the local staff, samples of the interviewees have been summarised in table 8.1. Due to the exceptional political circumstances at that time, the local people in Iraq were not allowed to be involved in the case project. This was confirmed with professionals involved within the Baghdad Congress Palace for the period 1978-1982.

Table 8.1: Local staff involvement

Local Staff Involvement Research Hypothesis 1 (RH1)	
Project Leader	"Due to the political reasons, there were restraints for local people, **We were not allowed to hire local people**, workers hired from Pakistan and Philippines."
Contracts manager (MALEMPO)	"The project was based on political background, so **the local people were not allowed** to be involved. Diaspora is very good idea, if they are qualified with Finnish know-how."
Const. Manager	"The political aspect was very clear which in turn imposes restrictions led **to denial e.g. local staff to be involved** within the case project due to security reasons."
Technical Manager	"**Local staff was banned to be involved** with us to work in case project."
Claims Manager	"**Local people were not allowed** to be involved for political reasons."
Ass. Claims Manager	"The political aspects were very clear as **the local staff which was very limited** as small team for the supervision tasks, and the employer was himself having a political background. Therefore, there was not real TT process."

Diasporas: Iraqis living abroad e.g. in Finland (Finn-Iraqis), qualified with Finnish qualifications and working to Finnish companies. They can be a vital factor to facilitate the TT process. They are considered as Finnish staff who have in addition to construction technology skills, they have the bicultural and bilingual skills which are considered as keys to open the TT process puzzles and settle the relationships between transferor and transferee.

According to the interviewees in their response to the questions (Appendix I), it was noticed that the diasporas' role in knowledge transferring sense would have been essential to reinforce the vertical TT mode in a way that could settle the existing knowledge gap by streaming knowledge/technology to be transferred from developed to developing countries (see table 8.2).

Table 8.2: Diaspora involvement

	Diaspora Involvement RH1
Project Leader	"Diasporas involvement in future projects will in turn facilitate the TT and definitely avoid the misunderstanding led by cross-cultural matters."
Contracts Manager (MALEMPO)	"Diaspora qualified with know-how, yes can be very helpful, if the use of diasporas for facilitating TT, not for translation or interpretation."
Const. Manager	"Diaspora, of course, they can very helpful in both TT process itself and in avoiding matters may come up from cross-cultural issues."
Technical Manager	"It would be much better to avoid all cultural aspects, if would diasporas have been involved within."
Claims Manager	"Diaspora is great idea, as they really make the TT process much easier, because their abilities and possessing professional skills in addition to culture and language skills."
Ass. Claims Manager	"Diasporas will definitely enhance the TT process as a whole due to their abilities and possessing bilingual and bicultural skills, further the latest qualifications."

8.3.2 Analysis of the Impact of Bicultural and Bilingual Factors

This factor has a significant impact on the TT process. This is confirmed by the interviewees by stating that cross-cultural and language aspects have a centric impact on the TT process as a whole according the interviewees statements (see table 8.3).

Table 8.3: Human centric language and culture impact on TT process

Human centric language and culture impact on TT process RH2	
Project Leader	"The local language capability will definitely help us in avoiding the cross-cultural maters; further help local people to absorb knowledge and skills easily."
Contracts Manager (MALEMPO)	"If language can be translated, the culture is not easy to deal with. Therefore, the role of bilingual and bicultural people is very important to solve the cross-cultural issues in the TT process."
Const. Manager	"The religious principles and other cultural aspects must to be understood, and I believe that bilingual people can solve it smoothly. Next, TT process is much easier if it is done with native language."
Technical Manager	"Language and culture are very useful for TT process. The second language is not

	enough for TT; but culture is more important than language as Arab culture was not very known to Finns."
Claims Manager	"Language and culture role is very important to improve TT process, furtherer human centric impacts on avoiding obstacles. We did not know the local culture."
Ass. Claims Manager	"The bilingual and bicultural skills are efficient in facilitating TT process by bridging and creating mutual communications."

The cross-cultural factor has appeared very clearly as evidence in the contract conditions itself e.g. the contract of the case project included one strange clause stated that *'the equipment must to be the best in the world'*. This was an open clause that cannot be reached as it was difficult to satisfy the client. Further, the client did not accept EC (European Code), instead only BS standard (British Standards) was accepted. Therefore, it was difficult to explain to the client to accept the EC standard. In addition to the changes and extensions after one year of undertaking the case project, all these issues related to the local culture. In terms of language barriers, the interviewees stated that the language factor has considerable impact on training local staff and it is remarkable in facilitating knowledge and technology transfer. According to the interviewees' comments, language would be helpful to facilitate knowledge and technology transfer, particularly the tacit knowledge. However, Dr. Palojärvi (one of interviewees), stated that language can be learnt within probably five years, whereas the culture needs decades of time. Again, it can be clearly noticed that culture and language have significant impact on TT process by effective transferring of knowledge, i.e. tacit knowledge, which needs socialisation and technology to local staff.

8.3.3 Analysis of the Political Impact

The political factor was apparently dominant in the case project as a whole due to the nature of the case project itself. The case project was targeted for the seventh conference for non-aliened states which was planned to be undertaken in Baghdad September 1982 which then did not occur in Baghdad at all due to the war situation at the time. Therefore, due to the political background of the case project, it was surrounded by specific team nominated by the vice-president to be liaising and management team. In other words, the role of this team was to control and spy any unusual behaviour by Finns. Thus, local staff was banned from getting involved within the case project tasks (see table 8.4).

Table 8.4: Political intervening & its restrictions

Political intervening & its restrictions impact on TT process RH1	
Project Leader	"I can say that the case project was carrying totally political background as it was targeting the seventh non-aligned states conference. Further, all manpower was controlled local supervision staff nominated by Iraqi government. Next, the local people were not allowed to be involved in the case project."
Contracts Manager (MALEMPO)	"The case project was definitely political as e.g. I was not invited to. The official reason that I was not involved, because Iraqi government did not want to touch any person who had had previous experience."
Const. Manager	"The political traits were very clear which in turn imposes restrictions led to denial e.g. local staff to be involved within the case project due to security reasons. Further, I noted by the chance in the basement level was very top secret tape recorder centre for the incoming and outgoing phone calls in the palace."
Technical Manager	"It is a political project as it was targeting the seventh non-aligned states conference and Saddam wanted to show his power."
Claims Manager	"The decision for not local people being allowed to be hired for the case project, this gave significant sign that the project was totally political."
Ass. Claims Manager	"The political aspects were very clear as the local staff which was very limited as small team for the supervision tasks, and the employer was himself having a political background."

It is worth to mention that the political decision has very essential impact on the TT process by utilising means that enhance the TT process by involving local people and diasporas within construction operation that can settle the knowledge gap. Again, it is noticed that any developing country eyeing to transfer technology projects has to make a political and strategic decision towards TT process and set a plan in advance with experts to avoid potential obstacles by choosing the relevant TT mode. This factor has very clear evidence that all interviewees mentioned frankly the political background was surrounding the case project as a whole.

According to the interviews' general sense, a clear pattern was generated indicates that the project was political rather than for public service purposes. Further, the key supervisor on the progress of the project was the Vice-President at the time. Local Iraqi employees were not allowed to work with Finns, only the administrative and supervisory staff appointed by the Vice- President. Consequently, there was no transfer of construction technology to Iraq due to the exclusion of Iraqi local staff from participating with Finns. Eventually, IRCO had to

hire workers from Pakistan, Thailand and Philippines. Therefore, there was an obvious lack of communication from both sides: the language barriers and conflicts and misunderstanding due to cross-cultural issues.

8.3.4 Analysis of the Impact of Contractual Agreement

The contractual agreement was one of the most important issues as it has commercial aspect with taking in account the competitiveness within the international market. The interviewees stated, that long term commercial partnership would encourage transferor to be willing to transfer their know-how and skills to transferee (local staff) (see table 8.5).

Table 8.5: Contractual mode impact on TT process

	Contractual mode impact on TT process RH1
Project Leader	"Contract included such odd articles that local people and Arabs are not allowed to be involved in the case project. Therefore, there were not TT practices i.e. it was not for such initiative. The long term JV contract is the best way for TT process that can enhance mutual trust and mutual communication between transferor and transferee."
Contracts Manager (MALEMPO)	"The contract was instead of including the specific terms in relation to TT, in contrast, there were ban terms included concerning keeping local people away from involving them within the case study. Therefore, I cannot see any initiative for TT process. However, the long term JV agreement will remove the fears of the transferor mind of losing biding competition in future projects."
Const. Manager	"The contract was not for TT process as the contract articles state that local people banned to be involved in case project. Further, we were not allowed to purchase materials and equipment, only cement, sand and gravel were allowed. This has given indicate that the contract was not for TT process, Next, there was unclear paragraphs such as (the equipment, devices and all materials have to be the best in the world) such paragraph was open, cannot be achieved, therefore, the case project was unprofitable itself, the contract cost increased to be four fold. The long term JV agreement gives more possibilities for the TT process success."
Technical Manager	"There was no any term regarding the TT process. The contract was not agreed in clear manner. I believe that long term JV will be more efficient in relation to TT

	process success."
Claims Manager	"The contract was not allowed to employ Iraqis, not to use local markets materials, equipment and others. The only can be bought from local markets was sand, cement and gravel. Therefore, the contract was not in sake of TT process. The best way for TT process, the long term JV agreement. This will enhance the ties between transferor and transferee for making clear initiative for TT process."
Ass. Claims manager	"The case project building was for the political aspects that enforce the contract terms which in turn hinder TT components to be used. Therefore, the contract in nature was not for real TT process. The TT lies only in the equipment and devices used in the case project and local manpower e.g. craftsmen were not allowed to be involved within the project for political aspects. JV agreements are more beneficial for TT process."

As per the comments of the interviewees in table 8.5, the long term contractual mode e.g. joint venture would enhance the mutual trust and communications between both transferor and transferee. Once, the mutual trust settled between transferor and transferee, the TT process will be as easer as possible by involving diasporas and local staff within TT projects**.** According to the interviewees comments that the long term joint venture partnership is the most essential in improving and reinforcing the TT process as a whole. The researcher finds that joint venture partnership is very renowned and useful to sustain the partnership between both transferor and transferee, particularly in the TT process. This can be noticed in USA, Europe, Japan, China and newly industrialised countries such as Malaysia, Singapore, and Indonesia.

8.4 Discussion of the SC Analysis

In the single case study, the horizontal transfer mode was applied in a form of a joint venture between some Finnish companies to perform Baghdad Congress Palace project in Iraq (figures 8.1 and 8.2). As for interviewees' data, nevertheless, were six senior managers interviewed, seemed as the interviews were conducted for one single interviewee due the clear correspondence between their responses. Furthermore, the findings of this factor were from real life context of Baghdad Congress Palace project done by IRCO Group. This indicates that the case company has been involved within the project for 4 years.

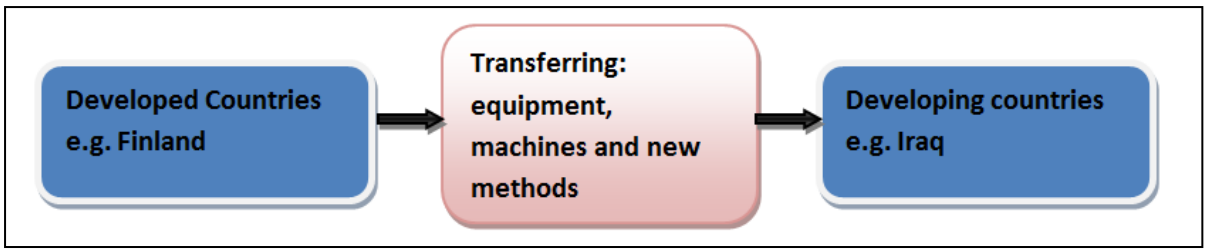


Figure 8.1: Horizontal technology transfer.

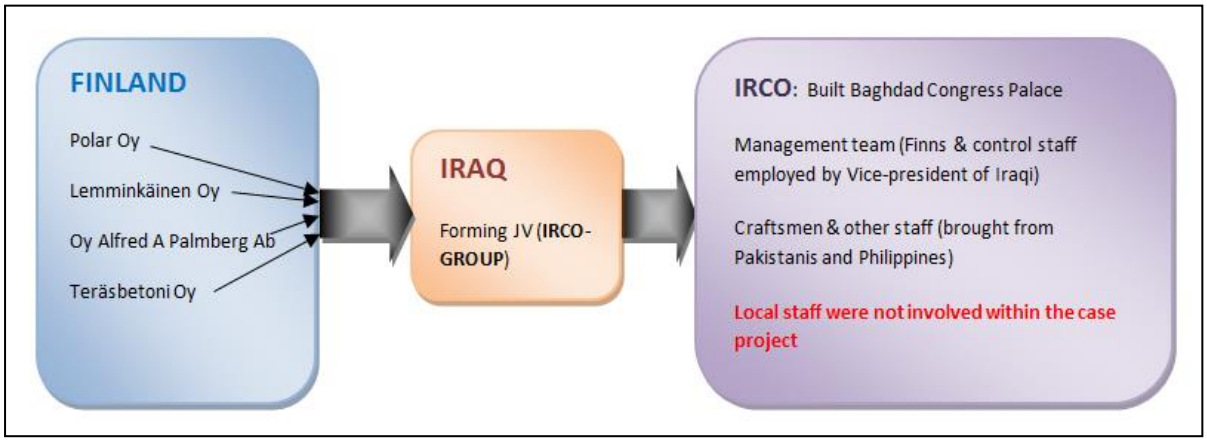


Figure 8.2: Horizontal transfer mode adopted in Iraq construction TT process.

According to the gathered data (see table 8.6), the construction TT process adopted in Iraq for the period 1970's and 1980's was horizontal transfer, which was adopted in the case of Iraq e.g. JV IRCO for Baghdad Congress Palace implementing.

Table 8.6: The TT process horizontal transfer

Was the construction technology transfer mode adopted in Iraq for 1970's and 1980's horizontal transfer?	
Project leader	Yes
Contracts Manager (MALEMPO)	Yes
Const. manager	Yes
Technical manager	Yes
Claims manager	Yes
Ass. Claims manager	Yes

In the SC case project, the training for operating the palace was included in the contract. However, this is still not enough to acquire knowledge and skills of construction technology to undertake potential projects in the future.

According to the above discussion, all interviewees are considering the diasporas involvement within projects is crucial in facilitating the TT process. The researcher agrees with this finding due to the fact that qualified diasporas with latest qualifications will enhance and duplicate the TT streaming. In other words, diasporas can play as a mediator (due to their language and cultural skills) between transferor's staff and transferee's staff on one hand, and on the other hand are considered as genuine staff of transferor possessing construction technology skills. Finally, the overall results of the interviewees of the single case study can be summarised in table 8.7. The list of full questions used in the interviews are listed in Appendix I.

Table 8.7: The overall results of single case study (Baghdad Congress palace project).

	Diasporas & local staff involvement	Human centric factors bicultural and bilingual	Political constraints	Contractual mode
Project Leader	Yes	Yes	Yes	Yes
Contracts Manager (MALEMPO)	Yes	Yes	Yes	Yes
Const. Manager	Yes	Yes	Yes	Yes
Technical Manager	Yes	Yes	Yes	Yes
Claims Manager	Yes	Yes	Yes	Yes
Ass. Claims Manager	Yes	Yes	Yes	Yes

8.5 Multi-Case Study Analysis

The multi-case study is conducted to cover various construction projects implemented by Finns in Iraq in 1970's and 1980's. Owing to wideness of this case study, eight of the professionals questioned with the electronic survey have responded (out of 20). The obtained data was analysed using appropriate quantitative methods to better understand the possible patterns of occurrences in the studied projects. The questionnaire conducted **is based on the proposed DTT model, which was inspired by the literature review and hypotheses of this study.**

It is worth to indicate that single case study focused on the four factors of the main DTT model, which are namely: local staff (training) and diasporas involvement, cross-cultural and language parries, political impact and contractual agreement. The multi-case study expands the focus of the SC to include other factors, namely the *input factors* and the *measurement factors*. The input factors refer to the factors that process TT, including Transfer Environment, Fin-Companies, Knowledge and Technology Integrator, Contractual Agreement, University-Industry Collaboration, Knowledge and Technology Acquisition, Public & Private Sectors. The measurement factors are used to determine the ultimate results of measuring the success of TT process, including Project Performance, Knowledge Resettlement and Integration, Return Migration, and Economic Advancement.

As a manner of interpreting the analysed data, there are three considered inductors to assess the measurements factors of the MC. These inductors are namely *T-test*, *median* and *correlation*. The independent t-test compares the means between two unrelated groups on the same continuous, dependent variable. The t-test procedure allows the testing of equality of variances (Levene's test) and the t-value for both equal- and unequal-variance. It also provides the relevant descriptive statistics (http://statistics.laerd.com). The rule adopted here is that if two or three indicators are satisfied, then the corresponding factor can be considered as a ***valid*** factor. Also, if only one indicator of the three indicators is satisfied and the other two are not, then the corresponding factor is considered as an ***invalid*** factor. For instance, if the T-test was N (non-significant), the median was more than 2.5, and correlation was approximately 1, then the factor can be considered as valid. However, if any factor fails in one of its three indicator results, then it does not affect the ultimate validity of that factor. Therefore, these indicators are interrelated with each other in determining the viability of the MC factors. Table 8.8 shows the results of analysing these indicators on the input factors.

Table 8.8: Statistical analysed data of input factors of Multi-case study (*S= Significant) & (*N= non-significant)

Items Input Factor	T-test S/N	Median ≥2.5	Correlation ≥0.5	Validity (Valid/Invalid)
Transfer environment				
Government policy (political impact)	S	4	0.809543	Valid
Economic development & Gross Domestic Product (GDP)	S	2.5	0.606674	Valid
Finnish companies (FC)				
Diasporas involvement	S	4	0.082479	Valid
Previous international experience	S	3.5	0.712525	Valid
Willing to train local staff	S	3	0.823722	Valid
Knowledge and Technology Integrator (KTI)				
Transferring latest technology qualification	S	4	0.900366	Valid
Bilingual (overcoming language barriers)	N	4	0.845154	Valid
Bicultural (overcoming culture barriers)	S	4	0.760639	Valid
Enhancing relationship between transferor and transferee	S	3.5	0.911685	Valid
Transfer mode				
Government commitment	S	4	-0.24298	Valid
Investment Law of Iraq	S	4	0.4082483	Valid
Transfer mechanism	S	3	0.4166667	Valid
Long term cooperative practice (Joint venture)	S	2.5	0.5631626	Valid
University-Industry collaboration and R&D				
Government support (funding)	S	3	0.81195	Valid
Private sector infrastructure	S	3	0.7116703	Valid
Proximity dimension	S	3	0.8665069	Valid
Knowledge and technology acquisition				
Choice & need of technology	S	4	0.8083954	Valid
Nature & complexity of technology	S	3	0.8741914	Valid
Communication	S	3.5	0.8215838	Valid
Training and acquisition ability	S	4	0.8838835	Valid
Economic environment	S	3.5	0.3127716	Valid
Political environment	S	3.5	0.7149109	Valid
Public & private sector				
Willing to learning	N	4	0.3962772	Invalid
Acquisition ability	S	3	0.8457426	Valid

The results of analysing the three indicators on the measurement factors are shown in table 8.9. The rule to be adopted here in how to consider a measurement factor for this study is similar to the rule mentioned earlier in table 8.8, which refers to the validity of a factor of two or more of the its corresponding indicators (T-test, median and correlation) are satisfied.

Table 8.9: Statistical analysed data of measurement factors of Multi-Case study (*S= Significant) & (*N= non-significant)

Items Measurement factors	T-test S/N	Median ≥ 2.5	Correlation ≥ 0.5	Validity (Valid/Invalid)
Project performance				
Domestic industry balance	S	3	-0.008269	Valid
Improved working practices	S	3.5	0.8674928	Valid
Schedule performance	S	3	0.6285649	Valid
Financial performance	S	3	0.8420754	Valid
Knowledge resettlement and integration				
Improved knowledge	S	3	0.8117077	Valid
Knowledge gap	S	4	0.6515838	Valid
Training and taught courses	S	3	0.615587	Valid
Long-term adopting of transferred skills	S	3	0.8504201	Valid
Return migration				
Socialisation (Tacit knowledge: tacit – tacit)	S	3.5	0.5925634	Valid
Qualified workers return to their homeland	N	3.5	0.6869095	Valid
Knowledge settlement	N	4	0.6831301	Valid
Eliminate privileged foreign elite	S	4	0.8095238	Valid
Economic advancement				
Competitiveness	S	3	0.5238835	Valid
New market	S	3.5	-0.1943251	Valid
Performance improvement	S	3.5	0.1210899	Valid

The analysed measurement factors indicate that the proposed DTT model is viable in improving the TT mechanism between developed and developing countries i.e. between Finland and Iraq as this study focused on Iraq TT experiment utilising the construction projects implemented by Finnish companies for the period 1970's and 1980's. However, the

pattern of quantitative data survey has clearly indicated that it was as similar as the qualitative e.g. local staff and diasporas involvement, cross-cultural and language barriers and contractual mode.

8.6 Discussion of the MC Analysis

The DTT model has two types of components in the multi-case study analysis. Firstly, there are main factors of the TT process that approved by statistical analysis as viable factors. These factors are the same ones that have been approved earlier in the single case study. Secondly, the measurement factors are considered as indicators to prove the validity of the proposed DTT model as a whole. As it was mentioned in the previous section, the MC expands the measurement factors of the SC to include further details of the corresponding measures that potentially affect the TT process in wider prospect. The measurement factors of the MC have been carefully chosen to consider all the possible measures to provide an effective international TT model. The *measurement factors* are described below:

- **Transfer Environment** – refers to the decision makers who adopt the suitable mechanism of transferring both knowledge and technology, including economic and government policies.
- **Fin-Companies** – refers to the willingness of the Finnish companies to involve diasporas and their willingness to train local staff.
- **Knowledge and Technology Integrator** – refers to the qualifications of the diasporas in terms of possessing bilingual, bicultural, and latest technology expertise (BBTs).
- **Contractual Agreement** – refers to the characteristics of the contract that ensure the mutual commercial relationship between the transferor and transferee in a way of overcoming the fears and misunderstanding of both sides.
- **University-Industry Collaboration** – refers to the availability of the local government support and private sector infrastructure.
- **Knowledge and Technology Acquisition** – refers to the choice/need of technology, nature/complexity of technology, communication, training and acquisition ability, economic/political environment.
- **Public & Private Sectors** – refers to the willingness to learn and the acquisition ability of the local staff in the transferee country.

- **Project Performance** – refers to the domestic industry balance, improved working practices, schedule/financial performance.
- **Knowledge Resettlement and Integration** – refers to improved knowledge, knowledge gap, training and taught courses, and long-term adoption of transferred skills.
- **Return Migration** – refers to socialisation, qualified workers return to their homeland, knowledge settlement, and eliminate privileged foreign elite.
- **Economic Advancement** – refers to competitiveness, new market, and performance improvement.

8.7 Discussion and Critiques

In order to evaluate the findings and outcomes of this study, this section will provide a critical evaluation that will compare the results of the existing literature as well as criticising the researcher's bias throughout the thesis. To measure the validity of the research, there are two types of concern to be addressed; internal validity and external validity, which will be covered and used in evaluating this study. The reliability of the research will be also examined in order to verify the repeatability of the outcomes beyond the experimental environment. Moreover, in order to criticise the genuineness of the research methodology and the neutrality of the researcher's opinions, the objectivity will be analysed and compared with the subjectivity of the research. Finally, it would be important to discuss and evaluate the applicability of the resultant model of this study and the future implication of adopting this model in other regions.

8.7.1 Internal Validity

Validity of a research represents the measure of how much the research is well grounded and logically acceptable. There are two approaches to investigate the validity of a research; internal validity and external validity. Internal validity refers to the approximate truth of the causal inferences of the observational outcomes of the study. It justifies the connection between the proposed 'cause' independent variables and the 'effect' dependent variables. Internal validity is usually referred to as a 'zero generalisability' concern since it proves that the findings of a research are only relevant and specific to the research study. In short, it is to

claim that what was done as evidence in the study has caused what was eventually observed (Trochim, 2006).

The main result of the SC and MC case studies is that the TT process from a developed to developing country can be improved by involving diasporas to facilitate the process effectively by overcoming the potential obstacles resulted from the cross-cultural and language issues within international TT process.

8.7.2 External Validity

In opposite to internal validity, external validity refers to the truth of generalising causal inferences of a study to other people, places or times. To ideally generalise the validity of a study, the results of the used methods should not be limited to particular circumstances, instead, critiques should be able to argue that the findings are applicable (with confidence) to people who were not involved in the study, to places other than where the methods were applied, and should be true in different times than when the methods were used (Trochim, 2006).

The external validity should be the connection or the bridge between the proposed hypotheses, which were supported by SC/MC case studies, and the key models in the literature review. This external bridge would establish the authentication of the anticipated conclusions of the research and confidently prove the likeliness of the research direction in this study with the research direction in the literature. The external validity of this study provides a comparison the research outcomes represented by the DTT model with the key models of the contextual literature, including the two case studies from China and Africa covered in chapter seven and the four TT models covered in chapter five (Extended TT Project Life Cycle Model, Technology Acquisition Model, Incorporating Tacit Knowledge Model, and Value-Added Model).

In order to verify the external validity of the research outcomes, table 8.10 is prepared to compare the DTT model and the other six models from the literature. The six models are the efforts of other researchers providing analysis and solutions in TT process between countries other than the DTT model environment and in different times than the period of SC/MC case studies.

Table 8.10: External Validity Comparison of the DTT Model with six models from the literature

#	DTT Model, 2012: *The Main Features of the Model*	China Model (Lai & Chao, 2006)	Africa Model (Janssen, 2010)	Project Life Cycle Model (Saad, 2002)	Technology Acquisition Model (Simkoko, 1992)	Tacit Knowledge Incorporating Model (Li-Hua, 2000)	Value-Added Model (Waroonkun, 2007)
From	Finland	USA	Netherlands	France	Sweden		
To	Iraq	China	Africa	Algeria	Africa	China	Thailand
1	Bilingual	✓	✓	✓			
2	Bicultural	✓	✓	✓			
3	Technology Experts	✓					
4	Political Influence	✓		✓			
5	Research & Development		✓				
6	Joint Venture	✓	✓			✓	
7	Contractual Agreement			✓			
8	Project Performance				✓		
9	Learning Environment						✓
10	Transfer Environment						✓
11	TT Mechanism: Transfer-I & Transfer-II				✓	✓	

8.7.3 Reliability

Reliability refers to the capacity of the results to be repeatedly achieved in other environments, in other times and by different people. This repeatability of the results gives the inspiration that the research methodology used to obtain these empirical results is *reliable* to be used outside the experimental environment (Palojärvi, 2009).

In this study, the reliability was enhanced by conducting a single and multi-case studies and using the case replication logic. An examination was conducted testing the findings of the single case study with inductive analysis, and the multi-case study findings with statistical analysis. The three statistical indicators: T-test, median and correlation are the opportunities of measuring the reliability of the TT factors. Such method has provided more opportunities and possibilities to address the viability and success of the argued and hypothesised enablers.

The reliability of the resultant model of this research (DTT) can be examined by considering two observations. First, the DTT model was built based on empirical data collected from interviews and questionnaires conducted and detailed in Appendices I and II. This empirical data represent the feedback and recommendations of the interviewees and surveyors on the preliminary design (Part C in Appendix II) of the DTT model and was then developed to the final DTT model (figure 6.6 in chapter six). The second observation to examine the reliability of the DTT model is that there is no contradiction between the research findings and the outcomes of the models in the literature review. Contrarily, the DTT was designed based on features that were almost similar to the theme of recommended research approaches to improve international TT process. In this sense, the DTT model can be considered reliable *due to the repeatability in the similar perspectives of other researchers covered in the literature of international TT process* such as the similar features between the DTT model and the six models in table 8.10.

Having said so, it is important to say that construction projects and its implementation conditions can considerably differ from each other depending on various reasons and circumstances. Therefore, it is difficult to anticipate how the managerial and organisational solutions for TT can work. However, in this research a systematic assessment of the model was made for better understanding how the proposed model would meet the needs of varying conditions.

8.7.4 Objectivity and Subjectivity

Objectivity of a research is accomplished when the results are unbiased, value-free with no contradiction of features and factors, and based on scientific facts/proof rather being contaminated with the author's perception. This is in opposite to *subjectivity*, which refers to assuming the result based on partial knowledge of the subject matter or the author's personal feelings. In contrast to subjectivity, the objectivity of a research ensures that there was no 'contamination' of the results by any individual involved in the testing – precisely, the results were not influenced by personal passion, emotions, interpretations or prejudices. This would purify the research from any subjective evaluations by relying on verifiable data (Gelmon, 2007).

A closer reader can question the objectivity of the DTT model when realising that the author of this research is a Finn-Iraqi; an Iraqi national lives in Finland. In the same time, the SC and MC are case studies of Finnish companies worked on construction projects in Iraq during the 1970s and 1980s. Was that a coincidence? To clarify this doubt about the objectivity of this research, the author has tried to keep the personal influence away from the analysis of the data.

- **Insider Justification**: The final design of the DTT model was neutrally built based on the feedback and the recommendations of the interviewees and surveyors who have been involved in the case studies. The author's own opinion and comments were kept for the discussion and conclusions and were reasonably kept away from proofs and facts, though, were referenced whenever possible.
- **Outsider Justification**: Choosing Finland as a developed country and Iraq as a developing country was due to the need of choosing a pair of developed-developing countries to investigate the TT process in international scale. This investigation was aimed to examine the role of the integrators (diasporas) in improving international TT process as a whole (*hypothesis-1*), as well as to investigate possibility of transferring knowledge and technology in a dual-streaming approach (*hypothesis-2*). In other words, it was a privilege for the author to possess the culture, language, and resources of both parties (Iraq and Finland) and all correspondent sources of information of the TT process took place back then. Understanding how both players have been engaged and realising the barriers associated with the TT process was an ideal environment for the author to produce high quality observations based on realistic and genuine knowledge of the experimental scene.

8.7.5 Applicability of the DTT Model

As it was explained in the external validity concern, it is important to generalise the findings of a research when extended to other people, places and times. The applicability of research findings refers to the generalisation ability of these findings when the experimental parameters and elements change.

The experience of Finnish experts in Iraq during the 1970s and 1980s (SC and MC) has significantly inspired the design of the DTT model. One can argue that the time of this experience is out-dated when trying to adopt the outcomes of this experience after over 30 years. In spite of seeing this argument convincing at the first glance, the author justifies this choice by claiming that the barriers faced back then are an old-new challenge. The DTT model is interestingly supported by most of the models and observations of relatively newer and recent experiences demonstrated in the literature review. For instance, a recent model such as the Netherlands-Africa case study (Janssen, 2010) supported the DTT model that to overcome the challenges of international TT process, full awareness of cultural barriers should be carefully considered. Moreover, the USA-China case study (Lai & Chao, 2006) supported the DTT model that the political influence could significantly affect international TT process; positively or negatively.

In conclusion, the DTT model can be applied with confidence between other developed and developing countries since it was not initially designed to be applied on specified country or region. The DTT model was meant to stand as an international TT framework between developed and developing countries/regions.

8.7 Summary

This chapter has covered the analysis and evaluation of the single and multi-case studies that were previously covered in chapter seven. The chapter has first indicated the strategy of the analysis approaches of the SC and MC case studies. The SC findings were analysed using the inductive reasoning approach, whereas the MC findings were analysed using a statistical approach. The four main factors of the SC have been considerably discussed as a core of the proposed DTT model. This was followed by a general discussion of the SC analysis for the case study of the Finnish companies that worked in Iraq during the 1970s-1980s. Then, the MC main factors have expanded the measurement factors that were indicated by the SC to cover all possible measures that may affect the TT process between developed and developing countries in construction projects. The MC measurement factors were analysed by validating the feedback responses from the conducted surveys. This was also followed by a discussion that further explained the measurement factors and its impact on the overall TT process. It has to be mentioned here that the number of the respondents of the MC was not up to the expectations, which was a limitation in the MC approach. Finally, the chapter ends with discussion and critiques section that link the analysis of the resultant DTT model with the hypotheses of this research, which reflected the successful approach that was followed to achieve the research objectives. The next chapter will cover the final conclusions and future work of this research.

CHAPTER 9

CONCLUSIONS

9.1 Introduction

As indicated in section 1.3, the aim of this research is to improve the appropriate approach for vertical knowledge and technology transfer in international construction operations between developed and developing countries. This broad aim was broken down into two objectives, which allowed the study to focus on the relevant issues. The first objective is to establish a new concept in TT by highlighting the important role of diasporas in international construction projects, whereas the second objective was to design a new TT model based on the new understanding from the first objective.

As per the research methodology, the tri-pillar research approach (literature review, SC and MC) was adopted in this study.

- ***The first pillar (theoretical part)***: the literature review focused on the common TT factors and extracted the most efficient ones such as language, cross-cultural, contractual mode and political impacts. The outcome of this pillar was the inspiration to develop the new proposed TT model (DTT).
- ***The second pillar (empirical part)***: the face-to-face interview was applied by the single case study, which discussed Baghdad Congress Palace as the responsibility of the Joint Venture (1978-1982); IRCO-Group, formed by four Finnish construction companies: Polar Construction Company, Lemminkäinen Oy, Oy Alfred A Palmberg Ab, and Teräsbetoni Oy. Interviews conducted for six senior professionals involved within the case project.
- ***The third pillar (empirical part)***: the questionnaire survey was conducted by professionals who were involved mainly within construction projects and other industry projects implemented by Finnish companies for the period 1970's and 1980's in Iraq.

Admittedly, the case studies are few decades old, which could weaken their potential relevance with respect of this research. However, these case studies can be seen as reference

points and sources of experiences of fundamentals of Iraqi culture and international TT that do not change quickly. Based on such experiences, the interviewed experts made their estimates and completed the survey. Moreover, two international TT operations including the Netherlands-Africa case study (Janssen, 2010) and USA-China case study (Lai & Chao, 2006) were provided as recent supporting evidence to enhance the DTT model testing.

This chapter draws together the research findings and its implications by linking these findings, which were presented in earlier chapters of the literature review, with the empirical findings from the SC and MC.

9.2 Key Findings and Implications

The first research objective was to establish new understanding about the importance of involving qualified diasporas in international construction projects to achieve efficient TT (section 1.3). Diasporas are seen as the enablers who can act as Knowledge and Technology Integrators (KTIs) due to their special abilities to transfer both knowledge and technology to local people since they are possessing bilingual, bicultural skills and technology expertise (BBTs). Such individuals can have a great impact on enhancing TT towards local people. The finding was supported by the explored models in the literature review (chapters four and five) and by the interview and survey results of the SC and MC case studies (chapter six). This also meets the *first hypothesis* (section 1.4) of this research, which indicates the importance of engaging diasporas (BBTs) in the TT process can potentially lead to successful performance of transferring knowledge and technology from the transferor to the transferee.

For instance, the case project of SC (Baghdad Congress Palace) is considered as a landmark for Finland and Iraq alike since it was equipped and built with high-standard construction technology of that period (late 1970s – early 1980s). However, after three decades, still in countries such as Iraq it seems to be an obvious problem that local construction companies do not encompass capabilities to construct such a large-scale project independently. Therefore, a key finding in this study is that international construction projects that are accomplished by developed countries (transferor) in developing countries (transferee) can effectively improve the local industries (and hence the local economies) of the transferee if a proper TT process was considered.

The second objective of the study was to develop a TT model for international construction projects capable of utilising the role of human involvement in such efforts (section 1.3). This objective was achieved by developing the DTT model (figure 6.6). The new developed model considered the second hypothesis (section 1.4) of this research, which indicates that the involvement of diasporas in international TT operations leads to dual technology transfer. By achieving this objective (designing the DTT model) and evaluating its effectiveness in vertical TT process, the aim of this research is also accomplished, which is improving vertical knowledge and technology transfer process in international construction projects from developed countries to developing ones.

To highlight the above findings, four key factors were identified to inherent the context of the research hypotheses. These four factors are the **Key Factors of the DTT model**, which are:

1. Involvement of Local Staff and Diasporas
2. Human centric factors bicultural and bilingual
3. Political constraints
4. Contractual mode

The relevance of the selected factors was supported separately according to the findings of SC/MC case studies and survey. The following list presents the main findings:

- ***The insufficient local staff training and diasporas involvement*** *was confirmed by all interviewees of the single case study (Baghdad Congress Palace) and by the main TT model survey. This led us to propose that RH1 is valid by suggesting that the involvement of diasporas (BBTs) and local staff can effectively enhance knowledge streaming within vertical TT. Furthermore, a novel part of this study is the concept and use of* ***Knowledge & Technology Integrators (KTI)*** *(diasporas) as mediators and who can facilitate to flow the knowledge and technology needed to be transferred.*
- ***Bicultural and bilingual skills as human centric factors*** *can have a significant importance that was demonstrated by all interviewees. Furthermore, the results of the main survey produced the same conclusion, which in turn led to the consensus of importance over the language and culture issues. This is taken as a supporting evidence of RH1 proposing that human-centric factors (bilingual, bicultural and*

technology experts) can facilitate the use of knowledge and technology effectively within the TT process.

- ***Political constraints*** *in this respect, the trends identified from the SC and MC findings show clearly that political constraints can have a significant impact on the TT process as a whole. This indicate the importance of engaging diasporas in the negotiations of international construction operations since they can facilitate the contractual agreement between the transferor and the transferee in circumstances where the political influence can eventually affect the consideration of TT process.*
- ***Contractual mode*** *is very crucial in terms of determining the wide lines of the strategy for the TT process as whole. Furthermore, it imposes both transferor and transferee to be abided by the terms of the agreement and remove the doubts caused by possible misunderstandings. The selected contractual mode was considered as vital viable enabler by both the interviews and the research surveys. It is worth to mention, that long term cooperative contractual arrangements such as a joint venture got a significant attention of the interviewees and the questionnaire surveys.*

Finally, there are two set of factors were resultant of analysing the MC findings (section 8.5) and were integrated in the DTT model, which are the **Input Factors** and the **Measurement Factors**. The first set, which is the input factors, includes the following factors: *Transfer Environment, Finnish Companies, Knowledge and Technology Integrator (KTI), Transfer Mode, University-Industry Collaboration and R&D, Knowledge and Technology Acquisition, and Public & Private Sectors*. The second set, which is the measurement factors, include the following factors: *Project Performance, Knowledge Resettlement and Integration, Return Migration, and Economic Advancement*. These two sets of factors were approved to be a complement to enhance and inherent TT process to be succeeded.

9.3 Contribution to Knowledge

This study has produced new knowledge capable to further explain the potential benefits of certain types of humans as a part of TT. The gained knowledge is grounded on the earlier TT models, which were covered in the literature review phase of the research. The earlier TT models recognise the main obstacles that can hinder the TT process e.g. language, culture and

knowledge decoding (tacit knowledge), but they have not taken into account how human-centric factors can be utilised in favour of the progress of TT process. In this study, a human expert (diaspora) of key relevance for successful TT has been identified as bilingual, bicultural and technology expert (BBTs). Diasporas with BBT skills can be considered as KTI (Knowledge and Technology Integrator) which in turn can facilitate the TT process effectively.

Since these 'BBT' factors embodied in KTIs can be incorporated in TT process model, the proposed model of this study can enable two streams of knowledge and technology flow. This feature (two streams knowledge and technology flow) is embedded in the proposed TT model and is called **Dual Technology Transfer**, and the resultant model is called the **Dual Technology Transfer model (DTT)**. The gained empirical findings propose that the DTT model can overcome obstacles, barriers and weaknesses that were identified in the earlier developed TT models covered in the literature review.

Moreover, this study has contributed new terms to the terminology of TT process. It is considered that the terms can prove valuable for planning and managing TT operations. These terms are the following:

- **BBTs** (Bilingual, Bicultural and Technology experts)
- **KTI** (Knowledge and Technology Integrator)
- **DTT** (Dual Technology Transfer)

The DTT model was evaluated by conducting intensive discussion and critiques to measure its validity (section 8.7). This included investigating the following:

- **Internal validity**: was accomplished by proving that the SC and MC findings have led to supporting the research hypotheses.
- **External validity**: was accomplished by comparing and proving the likeliness of the findings of the SC and MC with the findings from the models covered in the literature review.
- **Reliability**: was accomplished by measuring the repeatability of the resultant findings of this research in a way that does not contradict with the findings obtained from the literature review.

- **Objectivity and Subjectivity**: was accomplished by providing two sets of justifications; insider and outsider. These justifications have shown that the proposed DTT model was examined by the SC interviews and the MC questionnaires. Choosing the case study countries (Finland and Iraq) was justified due to the need for a pair of developed-developing countries to investigate the TT process in international scale.
- **Applicability**: was accomplished by comparing the DTT model, which was designed based on recommendations of Finnish experts worked in Iraq three decades back, with two recent international TT models (USA-China case study in 2006 and Netherlands-Africa case study in 2010). The comparison showed a strong link between the findings of these models although the time difference is obvious.

9.4 Limitations

As a critique over the completed research, some limitations and challenges have been identified, which arose during this study. The following list presents these limitations and challenges for the DTT model (figure 6.6 in chapter six):

- Number of candidates in the interview and questionnaire is an important measure for the credibility and reliability of the research findings and results. Having only 6 interviewees and 10 responses from questionnaires was the best possible number of candidates who could be contacted. This relatively low humble number of candidates for the SC and MC case studies was justified in chapter seven, including the difficulties in getting in touch with people involved in the case projects since the targeted period of this study is back to the 1970s and 1980s.
- The results would have been more effective if candidates from the Iraqi side who were involved in Baghdad Congress Palace have participated in the interviews and questionnaire surveying. The author of this research has made countless attempts to find those Iraqi candidates with no success. This is because of the sophisticated political situation in Iraq, which makes it almost impossible to get in touch with those who were nominated by the Iraqi government at the time.
- The research could have been enhanced by investigating the current conditions of the Finns projects that were discussed in the SC and MC case studies, and more importantly to study the opportunities that would have been available in Iraq if these projects were accompanied with proper knowledge transfer since that time.
- There has no mutual priority been investigated for the features and factors of the DTT model. This would be mandatory when implementing the model.

9.5 Further Research

A possible direction of further research can be undertaken in other developing country case study other than Iraq. The DTT model can be used as a pilot study in other countries facing similar problems, particularly in Meddle East to refine the DTT model and improve its applicability. For instance, The United Arab Emirates (UAE) can be a potential case study country, which is a recent rapidly developing country with massive opportunity to investigate the best TT model. According to the research key findings in terms of TT, the author of this research expects that UAE has been adopting the horizontal TT approach, which explains the obvious dependability on foreign companies in large-scale construction projects, such as Burj Khalifa skyscraper in Dubai (figure 9.1), the tallest structure in the world, which was constructed mainly by South Korean company; Samsung Engineering & Construction.

Another potential direction of research can concentrate on the ***economic dimension*** of developing countries that seek an optimal approach of TT. This can be accomplished by investigating all the possible opportunities to establish long-term commercial cooperative practice between developed and developing countries to enhance TT process. In addition, the impact of skilled diasporas on their ex-home country economies as they often return to set up new business in their home countries (The Economist, 2011). For instance, in some circumstance, utilising diasporas can be more efficient than education and training if they possess the three core characteristics of being KTIs: bilingual, bicultural and technology experts.

Finally, an interesting area of research could investigate how diasporas can be beneficial for their ex-home countries given the advantages and disadvantages of involving them in TT projects. This can be approached by conducting comparisons of how diasporas involvement in TT projects can provide viable and faster implication than educating and training local staff.

Figure 9.1: Burj Khalifa in Dubai

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APPENDIX (I)

SINGLE CASE STUDY WITH BAGHDAD CONGRESS PALACE INTERVIEW SURVEY ON TECHNOLOGY TRANSFER MODELS

Evaluation International Technology Transfer (TT) in Construction

This interview survey aims to measure the effectiveness of international TT in construction projects implemented by Finnish companies in Iraq for the period 1960s, 1970s and 1980s. The information will be used for academic purposes only, as one critical part of a Doctor of Science Technology research project. Individual responses will be kept confidential. Only a consolidated summary of the result may be published. This survey should take no longer than 3 hours.

Definition: International Technology Transfer (TT) in Construction

For the purpose of this study international technology transfer (TT) in construction has been defined as when some form of knowledge, material, procedure or equipment is transferred on construction projects from one foreign partner such as a person or organisation (transferor = your own company), to another local partner such as a person or organisation (transferee = client organisation), that arrange to receive it.

Part A: Background Information (*Optional)

First name* ---------- Surname*----------

Project Description: ----------

Position: □ Project Manager □ Site Engineer □ Consulting Engineer
□ Construction Manager/ Foreman □ Architect □ Other ----------

Name of Organisation* ----------
Type of Organisation: □ Main Contractor □ Sub-contractor

□ Consultant □ Other----------

Contact Address*----------

Phone (work*) ---------- E-mail*----------

Sex: □ Male □ Female

Age: □ Under 30 □ 30-40 □ 40-50 □ 50+

Education: □ High School □ Professional Qualification Diploma
□ Bachelor Degree □ Master Degree □ Doctorate Degree □ Other----------

How many years of experience do you have in the construction area?

□ 0-5 □ 5-10 □ 11-15 □ 16-20 □ 20+

How many projects have you been involved with where TT with a foreign partner was incorporated?

□ 1 □ 2-5 □ 6-9 □ 10+

Types of projects or business manoeuvres that characterise my experiences in Iraq

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Part B: Baghdad Congress Palace

The one of the marked projects built in Baghdad 1980s is Congress Palace. This was built by four Finnish companies (IRCO group) and designed by Kaija and Heikki Siren.

The lack of local staff and diasporas involvement

1. Was local staff involved in the project?
2. Have any skills been transferred to local staff?
3. How do you evaluate, if local staff would have been involved?
4. What do you think of involving diasporas in future projects in facilitating technology transfer?

Human centric factors bicultural and bilingual

1. Did you face significant problems in performing the project due to language and cultural barriers?
2. Will diasporas' human factor such as language and culture skills have effective impact on technology transfer?
3. In your opinion, is it vital to have diasporas involved in projects in developing countries?

4. Do you consider the cultural conflict/differences can be a reason to fail international projects in developing countries?

Political constraints

1. Why and how Finnish companies won the contract?
2. Was there a restriction from the local authority to prohibit the local staff to be involved in the project?
3. Did you experience that you were under surveillance while working for governmental projects?
4. What was the role of Iraqi local staff involved, if any?

Contractual agreement

1. Do you consider the project as part of technology transfer?
2. Were any clauses regarding the technology transfer included in the contract?
3. Did the contract involve any clauses for future training of local staff?
4. Did the contract allow/disallow the purchase of equipment from the local market in Iraq?

APPENDIX (II)

CASE STUDY SURVEY ON TECHNOLOGY TRANSFER MODELS

Evaluation International Technology Transfer (TT) in Construction

This survey aims to measure the effectiveness of international TT in construction projects implemented by Finnish companies in Iraq for the period of 1970s and 1980s. The information will be used for academic purposes only, as one critical part of a Doctor of Science Technology research project. Individual responses will be kept confidential. Only a consolidated summary of the result may be published. This survey should take no longer than 90 minutes.

Definition: International Technology Transfer (TT) in Construction

For the purpose of this study international technology transfer (TT) in construction has been defined as when some form of knowledge, material, procedure or equipment is transferred on construction projects from one foreign partner such as a person or organisation (transferor = your own company), to another local partner such as a person or organisation (transferee = client organisation), that arrange to receive it.

Part A: Background Information (*Optional)

First name*

Surname*

Project Description:

Position: ☐ Project Manager ☐ Site Engineer ☐ Consulting Engineer
☐ Construction Manager/ Foreman ☐ Architect

☐ Other

Name of Organisation*

Type of Organisation: ☐ Main Contractor ☐ Sub-contractor

☐ Consultant ☐ Other

Contact Address*

Phone (work*) E-mail*

Sex: ☐ Male ☐ Female

Age: ☐ Under 30 ☐ 30-40 ☐ 40-50 ☐ 50+

Education: ☐ High School ☐ Professional Qualification Diploma
☐ Bachelor Degree ☐ Master Degree ☐ Doctorate Degree

☐Other

How many years of experience do you have in the construction area?

☐ 0-5 ☐ 5-10 ☐ 11-15 ☐ 16-20 ☐ 20+

How many projects have you been involved with where TT with a foreign partner was incorporated?

☐ 1 ☐ 2-5 ☐ 6-9 ☐ 10+

Types of projects or business manoeuvres that characterise my experiences in Iraq

---

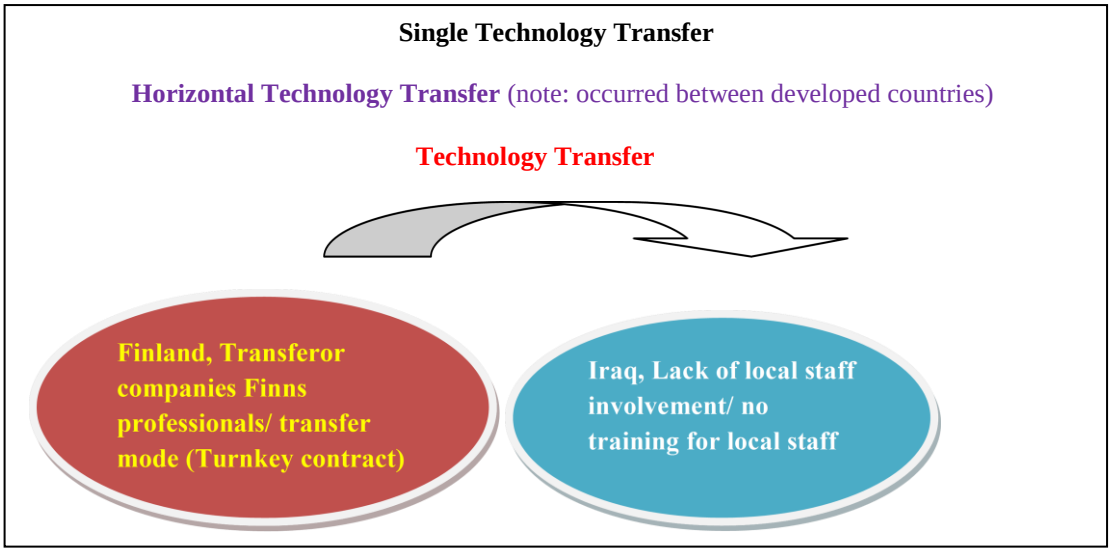
Part B: Evaluating International Technology Transfer when the traditional approach was applied

This part studies the factors that influence technology transfer approach in terms of positive and negative experiences. Iraq has undertaken construction technology transfer endeavour from Finland to Iraq during the decades 1970s and 1980s. This depends naturally on your case project. Please circle your selected rating, using the scale below, for following variables based on your experience on the projects you have been involved. Note that TT can be divided into two modes: ***horizontal technology transfer*** occurred between developed countries i.e. just transferring equipment and procedures as knowledge, know-how and technology are already existing, whereas ***vertical technology transfer*** occurred between developed and developing countries as latter need for new knowledge and technology which can be implemented by local staff training and involving them within TT process. In the traditional approach the dominating approach was the ***horizontal technology*** transfer that was also applied very much as such in the past Iraqi projects.

Scale for ranking options

1	2	3	4	5
Very Low / Poor	*Low / Poor*	*Adequate / Satisfactory*	*High / Good*	*Very High / Very Good*
Highly inappropriate	Inappropriate	*Satisfactory*	Appropriate	Highly appropriate

How do you evaluate the effectiveness of the following factors in the operations where the traditional model was applied in Iraq (1978-1982)?



Please make one selection

	1	2	3	4	5
Transfer mode	☐	☐	☐	☐	☐
Government policy and enforcement (influence)	☐	☐	☐	☐	☐
Language and culture differences	☐	☐	☐	☐	☐
Trust local partner	☐	☐	☐	☐	☐
Education level of local employees	☐	☐	☐	☐	☐
Local employees involvement	☐	☐	☐	☐	☐
Economic environment	☐	☐	☐	☐	☐
Transferors willingness to release their skills	☐	☐	☐	☐	☐
Fears of local partner competence	☐	☐	☐	☐	☐
Training of local staff	☐	☐	☐	☐	☐
Contractual agreement (not long term partnership e.g. turnkey)	☐	☐	☐	☐	☐

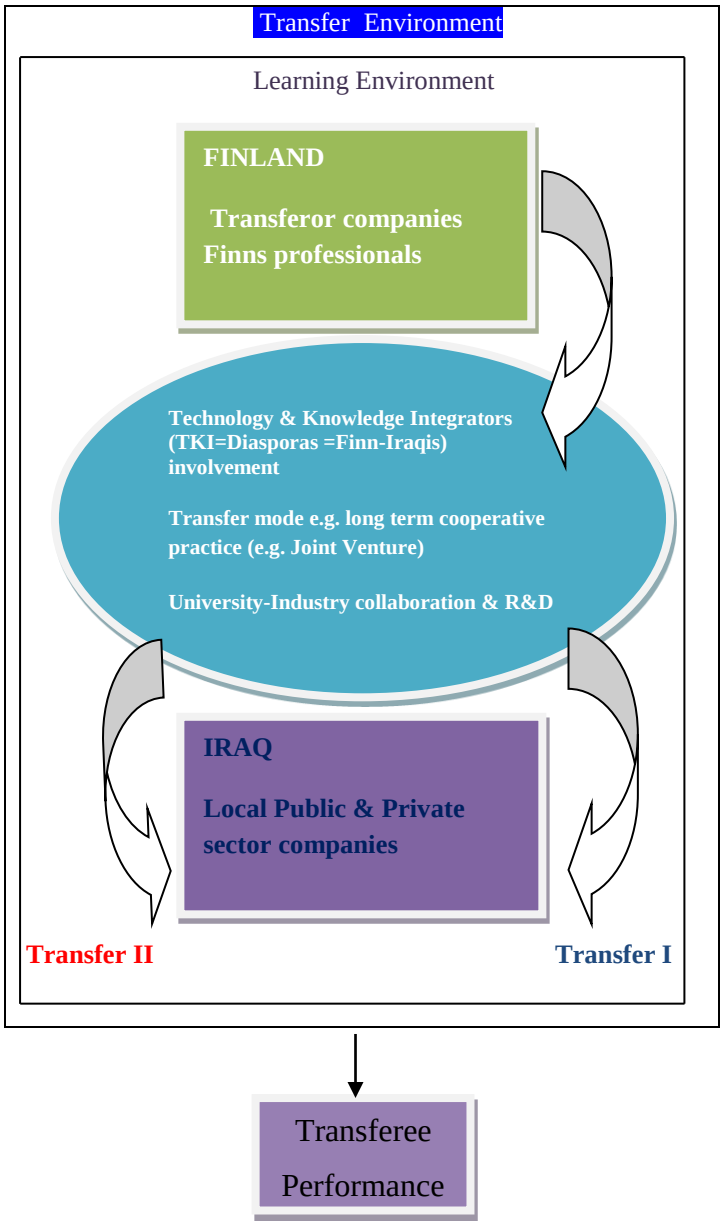
Part C: Evaluating the new International DTT Model

This part evaluates the new proposed international DTT model from Finland to Iraq. This international DTT model includes vertical technology transfer. Further, the role of the **Diasporas** (*hired qualified Finn-Iraqis living in Finland for decades*) in the TT process of activating the vertical technology transfer to become ***Dual technology transfer*** to be more effective and efficient in settling new technology in transferee's staff. In this proposed DTT model, diasporas role is duplicated as they in one hand, being as a mediators between Finns and Iraqi local staff and in the other hand, being qualified with Finnish qualification standards to train local staff, whereby considered as dual technology transfer. The DTT model was developed based on the literature review (retrospective TT research and models) and initial discussion which took place with Iraqis and some of Finns working at the precast factories built by Finnish companies such as Lohja Corporation (Rudus).

Please circle your selected rating, using the scale below, for following factors based on your experience on the projects you have been involved.

Scale for ranking options

1	2	3	4	5
Very Low / Poor	*Low / Poor*	*Adequate / Satisfactory*	*High / Good*	*Very High / Very Good*
Highly inappropriate	Inappropriate	*Satisfactory*	Appropriate	Highly appropriate



Transfer Environment: this is subjected to the transferee's local environment including economic development, Gross Domestic Product (GDP) and government policy and enforcement practices.

	1	2	3	4	5
TE 1 Economic development & Gross Domestic Product	☐	☐	☐	☐	☐
TE 2 Government policy & enforcement practices	☐	☐	☐	☐	☐

Finnish companies: this is subjected to the degree to which the willing to transfer the required knowledge.

	1	2	3	4	5
FC 1 Diasporas involvement	☐	☐	☐	☐	☐
FC 2 Previous international experience	☐	☐	☐	☐	☐
FC 3 willing to train local staff	☐	☐	☐	☐	☐

Knowledge and Technology Integrator KTI (Diasporas = Finn-Iraqis): this is subjected to the degree to which the willing of Finnish companies to qualify Diasporas (Finn-Iraqis) with latest technology and getting benefit of their skills of bilingual and bicultural to play as a moderate between Finnish and Iraqi collaboration.

	1	2	3	4	5
KTI 1 Transferring latest technology qualification	☐	☐	☐	☐	☐
KTI 2 Bilingual (overcoming language barriers)	☐	☐	☐	☐	☐
KTI 3 Bicultural (overcoming culture barriers)	☐	☐	☐	☐	☐
KTI 4 Enhancing relationship between transferor and transferee	☐	☐	☐	☐	☐

Contractual Agreement (Long term, transfer mode): this is subjected to the degree to which the vehicle of transfer facilitates the knowledge and technology transfer and concerned with the degree to which the host (Iraqi) government commitment to give assurances to transferor and investor within Foreign Direct Investment (FDI) initiatives.

	1	2	3	4	5
CA 1 Government commitment	☐	☐	☐	☐	☐
CA 2 Investment Law of Iraq	☐	☐	☐	☐	☐
CA 3 Transfer Mechanism	☐	☐	☐	☐	☐
CA 4 Joint venture (long term cooperative practice)	☐	☐	☐	☐	☐
CA 5 Turnkey contract	☐	☐	☐	☐	☐
CA 6 Licensing	☐	☐	☐	☐	☐

CA 7 Franchising	☐	☐	☐	☐	☐
CA 8 Sub-contracting	☐	☐	☐	☐	☐
CA 9 Integrated packages	☐	☐	☐	☐	☐
CA 10 Other	☐	☐	☐	☐	☐

University-Industry collaboration and R&D: this is subjected to the degree to which Iraqi government undertakes to establish research centres and set a strategy of collaboration between universities and industry in Iraq.

	1	2	3	4	5
UIC 1 Government support (funding)	☐	☐	☐	☐	☐
UIC 2 Private sector infrastructure	☐	☐	☐	☐	☐
UIC 3 Proximity dimensions	☐	☐	☐	☐	☐

Knowledge and Technology Acquisition: this is subjected to the degree to which local labours improve their skills and efficiency by new knowledge and technology acquisition to be qualified for further projects.

	1	2	3	4	5
KTA 1 Choice & need of technology	☐	☐	☐	☐	☐
KTA 2 Nature & complexity of technology	☐	☐	☐	☐	☐
KTA 3 Communication	☐	☐	☐	☐	☐
KTA 4 Training and acquisition ability	☐	☐	☐	☐	☐
KTA 5 Economic environment	☐	☐	☐	☐	☐
KTA 6 Political environment	☐	☐	☐	☐	☐

Public & Private Sectors of Iraq: this is subjected to the degree to which acquisition ability of local employees.

	1	2	3	4	5
PPS 1 Willing to learning	☐	☐	☐	☐	☐
PPS 2 Acquisition ability	☐	☐	☐	☐	☐

Transferee Performance: *this is subjected to the degree to which the transferee able to perform the further projects him/herself. This enabler has four variables namely: project performance, knowledge resettlement and integration, return migration – (Diasporas 'qualified Iraqis living abroad') and economic advancement.*

Project Performance: this is subjected to the degree to which the success of the overall performance in construction projects delivery should result from effective technology transfer**.**

	1	2	3	4	5
PP 1 Domestic industry balance	☐	☐	☐	☐	☐
PP 2 Improved working practices	☐	☐	☐	☐	☐
PP 3 Schedule performance	☐	☐	☐	☐	☐
PP 4 Financial performance	☐	☐	☐	☐	☐

Knowledge Resettlement and Integration: this is subjected to the degree to which knowledge absorbed by local staff from developed country.

	1	2	3	4	5
KRI 1 Improved knowledge	☐	☐	☐	☐	☐
KRI 2 Knowledge gap	☐	☐	☐	☐	☐
KRI 3 Training and taught courses	☐	☐	☐	☐	☐
KRI 4 Long-term adoption of transferred skills	☐	☐	☐	☐	☐

Return Migration – (Diasporas qualified Iraqis living abroad): this is subjected to the degree to which Diasporas 'migrant brains' return back to their home land in order to participate in rebuilding projects.

	1	2	3	4	5
RM 1 Socialisation (Tacit Knowledge: Tacit-Tacit)	☐	☐	☐	☐	☐
RM 2 Qualified workers return to their homeland	☐	☐	☐	☐	☐
RM 3 Knowledge settlement	☐	☐	☐	☐	☐
RM 4 Eliminate privileged foreign elite	☐	☐	☐	☐	☐

Economic Advancement: this is subjected to the degree to which TT programmes have improved the competitiveness of host firms in the domestic and international market and with the degree to which TT programmes have enabled the transferee to perform at a higher level.

	1	2	3	4	5
EA 1 Competitiveness	☐	☐	☐	☐	☐
EA 2 New market	☐	☐	☐	☐	☐
EA 3 Performance improvement	☐	☐	☐	☐	☐

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